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MONTEREY, CALIFORNIA

MBA PROFESSIONAL REPORT

Cost Benefit Analysis of Government Furnished Equipment versus Contract Furnished Equipment for the Procurement and Integration of the MK-44 Chain Gun with the United States Marine Corps Expeditionary Fighting Vehicle

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By: James E. Howard
Patrick B. Collins

March 2005

Advisors: Thomas W. Crouch
William R. Gates

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The Direct Reporting Program Manager (DRPM) for the USMC's Expeditionary Fighting Vehicle (EFV) is conducting an analysis of two acquisition tactics concerning the commercial procurement of the MK-44 to be integrated with the EFV. The EFV is manufactured by General Dynamics (GD) and the MK-44 chain gun is manufactured by Alliant Techsystems Inc. (ATK). The analysis is the topic of this thesis and will assist the DRPM in determining which of two tactics the Government should use for the procurement of the MK-44. The two arrangements of acquiring and integrating the MK-44 are 1) to procure the MK-44 as government furnished equipment (GFE) or 2) to procure the MK-44 as contractor furnished equipment (CFE). The fundamental difference is that a GFE arrangement will provide a direct contractual relationship between the Government and ATK, whereas, a CFE contract will eliminate that relationship as ATK will become a sub-contractor to GD, the prime contractor for the EFV. These two options present a variety of issues, both tangible and intangible, for analysis in determining which approach is most advantageous, with respect to cost and risk, to the Government.

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ABSTRACT

The Direct Reporting Program Manager (DRPM) for the United States Marine Corps Expeditionary Fighting Vehicle (EFV) is conducting an analysis of two acquisition tactics concerning the commercial procurement of the MK-44 chain gun to be integrated with the EFV. General Dynamics (GD) manufactures the EFV and the MK-44 is manufactured by Alliant Techsystems Inc. (ATK). The purpose of this thesis is to assist the DRPM in determining which of two tactics the Government should use for the procurement of the MK-44. The two alternatives for acquiring and integrating the MK-44 are: 1) to procure the MK-44 as government furnished equipment (GFE), or 2) to procure the MK-44 as contractor furnished equipment (CFE). The fundamental difference is that a GFE arrangement will provide a direct contractual relationship between the Government and ATK, whereas, a CFE contract will eliminate that relationship as ATK will become a sub-contractor to GD, the prime contractor for the EFV. These two options present a variety of issues for analysis in determining which approach is most advantageous, with respect to cost and other risk, to the Government.

The key findings of our research indicate the MK-44 is a favorable candidate for a CFE arrangement. This particular CFE arrangement will provide a value added service to the Government adequately justifying GD's Profit Rate. Additionally, a CFE arrangement allows the Government to reduce the overall program risk by transferring the cost, schedule, performance and integration risk associated with the MK-44 to GD.

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I. INTRODUCTION

A. BACKGROUND

The Direct Reporting Program Manager (DRPM) for the United States Marine Corps Expeditionary Fighting Vehicle (EFV) is conducting an analysis of two acquisition tactics concerning the commercial procurement of the MK-44 chain gun to be integrated with the EFV. General Dynamics (GD) manufactures the EFV and the MK-44 is manufactured by Alliant Techsystems Inc. (ATK). The purpose of this thesis is to assist the DRPM in determining which of two tactics the Government should use for the procurement of the MK-44. The two alternatives for acquiring and integrating the MK-44 are: 1) to procure the MK-44 as government furnished equipment (GFE), or 2) to procure the MK-44 as contractor furnished equipment (CFE). The fundamental difference is that a GFE arrangement will provide a direct contractual relationship between the Government and ATK, whereas, a CFE contract will eliminate that relationship as ATK will become a sub-contractor to GD, the prime contractor for the EFV. These two options present a variety of issues, both tangible and intangible, for analysis in determining which approach is most advantageous, with respect to cost and other risk, to the Government.

B. PURPOSE

The primary objective of this thesis is to examine what decisions and types of analysis should be made when confronted with a multiple contractor acquisition and integration issue such as GFE versus CFE. This paper will conduct an analysis and apply it to the MK-44 procurement decision faced by EFV Program Office. A secondary objective is to educate and create a document of lessons learned that will help future Program Managers (PM) to better analyze the correct approach to deciding whether to purchase GFE or CFE.

C. SCOPE

This thesis seeks to comprehensively analyze the cost and risk factors relevant and pertinent to contract procurements involving a GFE or CFE decision. Additionally, this thesis aims to identify and examine cost aspects particular to a DoD acquisition PM that are difficult and challenging to estimate. The cost aspects are absolutely necessary for an equitable comparison of government furnished services or goods to contractor furnished services or goods. Finally, this thesis will indicate specific conditions that most often predicate a GFE or CFE arrangement. The scope of this thesis will focus on identification and analysis of all relevant cost drivers. In the event that cost does not elicit a clear decision and the decision hinges on one or more acquisition risk areas presented in this thesis, a recommendation will be made for further research in that particular risk area.

D. METHODOLOGY

This thesis will explore the concepts highlighted in the Scope paragraph by conducting an in-depth analysis of the USMC EFV Program Office's options for procuring the MK-44 from ATK and integrating it with the EFV being manufactured by GD. This analysis will be based on literature research from books, theses, journal articles and several internet resources. Interviews with personnel from the EFV Program Office, ATK and GD will be sourced. Interviews with past and present program managers of the US Army's Apache program and the Joint Strike Fighter program will also be conducted. All relevant and supportable cost drivers will be analyzed and interpreted. To the extent possible, cost ranges will be established to portions of GD and ATK's cost structure subject to changes over time due to market or economic conditions. Additionally, all identified risk aspects will be discussed and evaluated for appropriate analysis. Acquisition risk areas associated with this analysis will be validated by the EFV Program Office with agreed level of importance for all risk factors.

E. RESEARCH QUESTIONS

Primary:

1. Is the procurement and integration of the MK-44 more advantageous to the Government under a GFE or CFE arrangement?

Secondary:

1. What cost drivers are critical to an equitable comparison between a GFE and CFE arrangement?
2. What risk factors are critical to a GFE or CFE analysis?
3. What acquisition, market or economic conditions cause one arrangement to be preferred to the other?

4. What are the possible methods of analyzing intangible considerations relevant to a GFE or CFE decision?

F. ORGANIZATION

Chapter II contains a background of the EFV and development of the Direct Reporting Program Office. The reason for selecting the MK-44 will follow with a description of the two methods to procure the MK-44, GFE and CFE.

Chapter III will explore the cost issue. This chapter will introduce cost items and follow with the history of the cost elements in the EFV program. This will be preceded by a break down of the costs of the MK-44 by fiscal year. This will be analyzed along with an interpretation of the Office of Management and Budget (OMB) A-76 outsourcing program and how this relates to what the government is trying to accomplish.

Chapter IV explores and discusses issues that are associated with the three main elements of risk. This chapter will begin by describing the risks associated with cost followed by performance and schedule. Each element of risk will be analyzed as GFE and CFE. This chapter will conclude with the identification of which arrangement will contain the greatest amount of risk.

Chapter V will discuss lessons learned from current day programs that may be applied to the programmatic tactics, techniques and procedures to help bring awareness of current successes and failures. This will also provide a reference for future programs to learn from.

Chapter VI will summarize the findings of this report, answer the research questions and provide a recommendation from this study for the EFV program office.

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II. HISTORY OF THE EXPEDITIONARY FIGHTING VEHICLE

A. BACKGROUND

> National Security Strategy has shifted from a focus on global threat to a focus on regional challenges and opportunities. While the prospect of global war has receded, we are entering a period of enormous uncertainty in regions critical to our national interests. Our forces can help to shape the future in ways favorable to our interests by underpinning our alliances, precluding threats, and helping to preserve the strategic position we won with the end of the Cold War. Naval Forces will be full participants in the principal elements of this strategy – strategic deterrence and defense, forward presence, crisis response, and reconstitiution. (Ref. 4)

Our National Security Strategy requires a strong forcible entry capability; the USMC provides this forcible entry capability with the EFV, formerly called the Advanced Amphibious Assault Vehicle (AAAV). Title 10 of the US Code directs the USMC to develop the necessary means to achieve victory in amphibious operations. The USMC solution to this problem was the Amphibious Assault Vehicle (AAV), which has served the USMC for over thirty years.

The USMC identified deficiencies in their current AAV, in the Mission Need Statement 176970, dated 19 August 1988. The deficiencies were due in part to the age of the current AAV and the continuing advancements in non-Soviet fielded threat technologies. From this Mission Needs Statement and the Operational Requirements Document (ORD), the USMC embarked on the EFV. The EFV is the USMC's primary means of accomplishing surface power projection and, if necessary, forcible entry against any level of defended coastline. The EFV is a self-deploying, high-water-speed, armored amphibious vehicle capable of seamlessly transporting Marines from ships located over the horizon to inland objectives. The EFV will allow the USN and the USMC to link maneuver at sea and maneuver ashore in all types of amphibious operations, including those employing the Operational Maneuver from the Sea concept. (Ref. 26)

The EFV is fully armored and capable of carrying up to seventeen combat loaded Marines. The EFV is able to use oceans, rivers, lakes, and seas as avenues of approach and maneuver for the landing forces. The EFV has two variants; the personnel variant and the command variant. The EFV is currently half way through the system development and demonstration phase. (Ref. 2)

The greatest benefit of the EFV is the speed with which it is able to cover land and water distances. The EFV is able to move at thirty knots in calm water. The EFV is equipped with a powerful 2,700 HP diesel engine. The EFV is able to attain land speeds of up to 45 mph, allowing it to keep up with the M1A1 Abrams main battle tank. The lack of land speed capability is the primary detractor of the AAV as it is unable to keep up with the M1A1 tanks. With all these benefits, the price tag is also impressive, at around seven million dollars apiece. (Ref. 2)

The EFV is able to fight day or night with the help of the second generation FLIR system. There is also a laser range finder to aid the targeting process. The EFV has also been upgraded with the ability to fight within a Nuclear, Biological or Chemical environment.

B. DIRECT REPORTING PROGRAM MANAGER

In June of 1996, the USMC awarded the Demonstration/Validation phase contract to develop a single EFV prototype to GD. This began the EFV acquisition program and was responsible for establishing an innovative first for an acquisition program office.

The contract was awarded to GD with the stipulation that the EFV Technology Center be located within twenty miles of the Pentagon and the USMC Combat Development Command in Quantico, Virginia. GD located the building in Woodbridge, Virginia. This new building was designed to hold GD's entire EFV production workforce and all EFV government employees. This was not only a first for the USMC, but also a first for the DoD acquisition community. This co-location allowed aggressive use of the Integrated Product and Process Development (IPPD) concepts. This also allowed for better communication, lower travel costs and better program oversight on Total Ownership Cost (TOC).

In addition, the location of the EFV center allowed the program office to use Marines, from the Operating Forces, Marine Schools, and Marine Corps Combat Development Command. These Marines provided insights to improve the design of the EFV during its development stage. The program office incorporated these Marines into the Integrated Product Teams, where the Marines shared their knowledge and experience on issues such as maintenance and operation of the AAV's in a field environment. This will help ensure the same mistakes are not carried over to the EFV. (Ref. 26)

This co-location has been integral in developing the EFV and has been a tremendous asset in establishing precedence for future DoD acquisition programs. This combined team has inspired the USMC and GD to create the very best in the next generation EFV for the Marines to continue to accomplish the mission of tomorrow. Included below is the EFV program schedule as of November 2003.

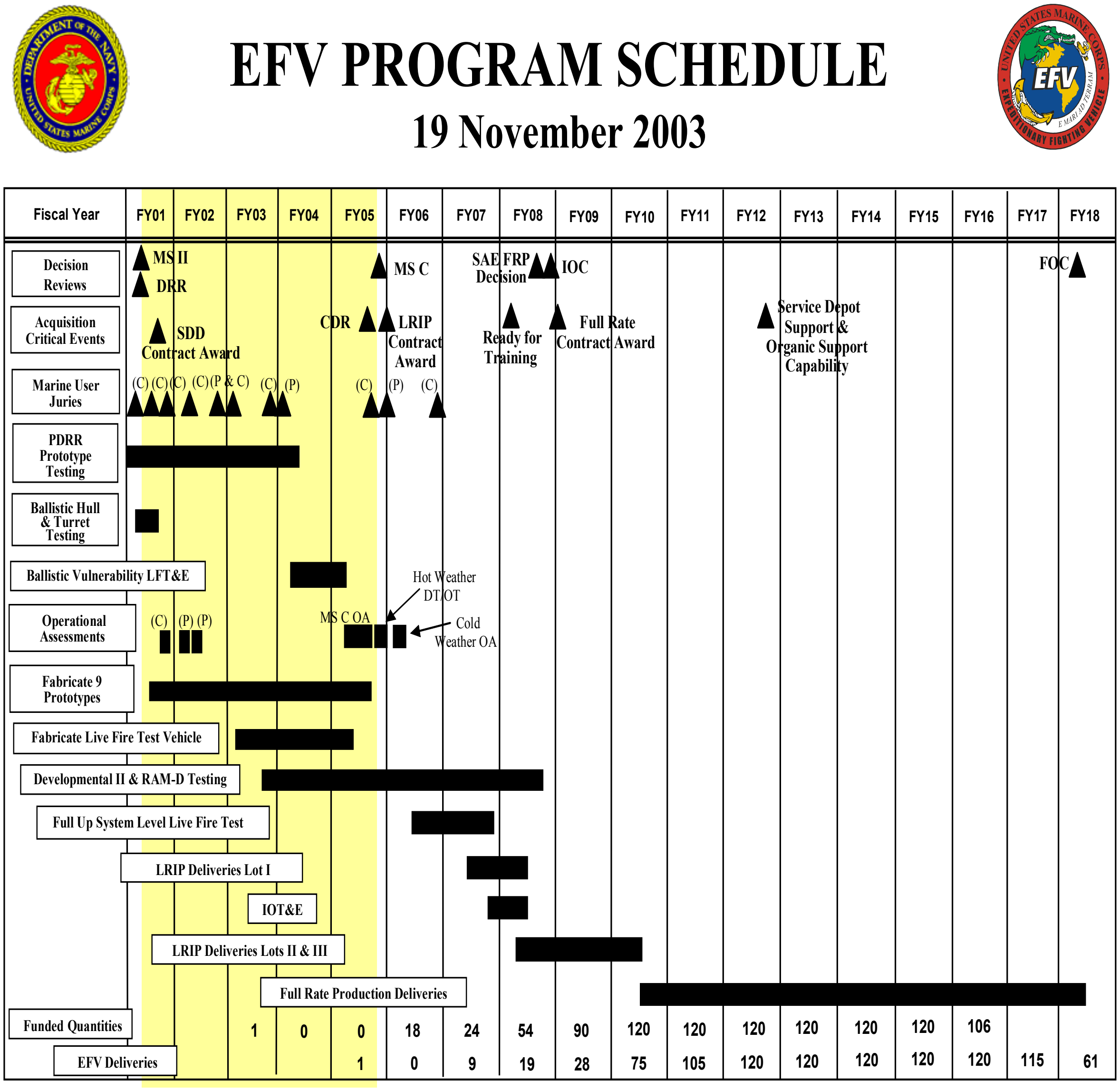

Figure 1. EFV Program Schedule (From: Ref. 26)

C. USMC SELECTS THE MK-44

The EFV program originally started in the mid 1970s, but several cancellations and restarts delayed further action until the late 1980s. The program was finally approved and a Program Management Office was mandated for EFV concept development and exploration in June 1990. There were originally two contractors; GD and United Defense Limited Partnership were employed during the concept exploration phase. Following the Milestone A decision in March of 1995, GD was awarded a Cost-Plus-Award-Fee (CPAF) contract in June 1996 to develop the EFV prototype.

The USMC set the lethality threshold for the EFV's main gun to destroy, neutralize, or suppress antitank weapons, light armored vehicles, emplacements / bunkers, and dismounted infantry. The maximum effective range of the main gun was specified to be 1500 meters. (Ref. 4) The Medium Caliber Armament Study (MCAS) was conducted to determine the right gun for the USMC. The results of this study persuaded the USMC to go with the MK-44 Gun System, manufactured by ATK.

The USMC chose this weapon system because it had the highest kills per stowed load lethality (Super 40), second lowest system weight, super 40 growth potential and permitted the "train in 30 fight in 40 concept". The MK-44 presently can fire 30mm ammunition; however, after changing the barrel and some feed sprockets, the MK-44 is able to fire super 40mm ammunition, hence the train in 30 fight in 40 motto. The MK-44 is capable of firing APFSDS-T (Tungsten Long Rod), HEI-T/MPLD, TP/TP-T, and SAPHE-T rounds. With the MK-44's ability to fulfill the USMC criteria for lethality, the array of potential ammunition, and upgradeability to 40mm ammunition, the USMC has officially selected the MK-44 Gun System for the EFV.

The MK-44 actually refers to the physical gun itself. When the gun is placed in the turret of the EFV, it is referred to as the MK-46 Gun System. The MK-46 uses the same Army fire control system that is on the M1A1 Abram's main battle tank. This provides the stabilization needed for the EFV to fire while on the move over land or water. There is also a coaxial 7.62mm M240 machine gun located in the MK-46. (Ref. 2)

ATK is a major U.S. aerospace and defense contractor with sales of approximately $2.2 billion. ATK has strong positions in propulsion, composite structures, munitions, precision capabilities, and civilian and sporting ammunition. It is the nation's leading manufacturer of ammunition and world's leading supplier of solid propulsion systems. (Ref. 5) ATK was originally a part of Honeywell; however, ATK was spun off in 1990. ATK has made many acquisitions since that time to increase its presence in the US market. One such acquisition was in 2002 when ATK bought Boeing's ordnance business, which merged ATK's munitions portfolio with the nation's leading gun producer.

The MK-44 was procured for the System Development and Design Phase from ATK as GFE. The acquisition strategy for the EFV Program Office has identified the MK-44 as an exception to the overall strategy of keeping Government Furnished Property to a minimum. (Ref. 29) However, in keeping with the strategy the DRPM has decided to ensure the EFV program makes a calculated and competent decision between competing tactics, GFE or CFE.

The period of time from the original ATK/MK-44 contract to the present day GD contract for EFV LRIP and FRP has been tremendously unstable with regards to military actions, economic conditions and DoD acquisition reforms. Consequently, the DRPM, as a manager of public funds, has to re-evaluate a direct contract (GFE arrangement) with ATK for the MK-44 against the potential of a CFE arrangement with GD. With the cost environment of government contractors constantly changing, decisions made two or three years ago may not be in the best interest of the government today. This thesis analyzes how cost drivers have changed over time and what methods are available to take full advantage of those changes. This will also bring into view when one type of arrangement is more advantageous over the other.

D. GFE AND CFE DEFINITION

1. Government Furnished Equipment

GFE is defined in Section 45.101 of the FAR as: "Government property means all property owned by or leased to the Government or acquired by the Government under the terms of the contract. It includes both Government furnished property and contractor-acquired property." (Ref. 6) There are implied risks that the Government will bear with this type of arrangement. When the Government provides equipment to a prime contractor, the Government is now in a position where they will be responsible for how this equipment integrates into the system. If the system does not meet the performance requirements established, the contractors can blame the Government's equipment as the cause of this performance degradation. The Government also now takes on the risk of ensuring that the equipment is delivered on time to the prime contractor in order to allow the contractor to maintain their established production schedule. Thus the Government now takes on additional schedule risk. Thus when the Government decides to go with a GFE arrangement there are additional risks that the Government inherently takes on.

2. Contractor Furnished Equipment

CFE is defined in Section 45.101 of the FAR as: "Contractor-acquired property means property acquired or otherwise provided by the contractor for performing a contract and to which the Government has title." (Ref. 6) With a CFE arrangement the Government will place all the risk on the contractor by having the contractor responsible for all aspects of the equipment being procured. The contractor is willing to do this for a fee, which is charged to the Government. The contractor, in agreeing to this, will take on all risks to include cost, schedule, and performance risks associated with this arrangement.

3. CFE versus GFE Demonstrated

The two concepts above, as defined by the FAR, can be illustrated by examining one of many system acquisitions. As an example, a DoD acquisition Program Manager is responsible for the procurement of the next generation military transport truck. The prime contractor would be selected from a pool of competitors; in this example OshKosh is selected. The Program Manager, as well as OshKosh, understands that several major components will come from original equipment manufacturers (OEM) other than OshKosh. Specifically for the truck, the engine and transmission could potentially come from different OEMs (i.e., Cummings) and OshKosh would simply integrate that item into the production process of the truck.

The Program Manager has a decision to make concerning the method by which the Government supplies the engine and/or transmission to OshKosh. The two methods are CFE or GFE. As stipulated by the definition above, the CFE arrangement places all aspects of responsibility associated with procurement and integration with the prime contractor. In this case, OshKosh would have the sole responsibility to procure and integrate the CFE item and manage a sub-contractor.

Conversely, with a GFE arrangement, the PM retains the responsibility of procuring and coordinating the integration of the GFE item with the principle end item. In this case, the PM will have two separate contracts, one with the prime contractor and another with the OEM of the GFE item, the sub-contractor under a CFE arrangement. In most cases, a GFE arrangement does not imply that the Program Manager or Government takes possession of the GFE item. Instead, the Program Manager coordinates performance and delivery schedules and pays the prime contractor a fee to accept, handle and store the GFE item until it is required in the production process for integration.

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III. COST

A. INTRODUCTION/COST DRIVER IDENTIFICATION

Current acquisition methodology dictates the use of Cost As an Independent Variable (CAIV) when analyzing procurement options. This analysis is no different. The focus is going to be on the elements of cost associated with the MK-44 procurement under both a GFE and CFE arrangement. The first category of cost drivers is those costs associated with a GFE arrangement. The second category of cost drivers is those costs associated with a CFE arrangement. The costs associated with both alternatives are quantifiable. However, two costs associated with a GFE arrangement, opportunity cost and overhead cost, are unsupportable and outside the scope of this thesis. The key to a reliable explanatory cost analysis is obtaining accurate data for quantifiable cost elements, as well as developing reasonable proxies for the unsupportable cost elements.

1. Identification of GFE Cost Drivers

The first set of cost drivers to be identified with a GFE arrangement is opportunity cost, Government overhead rates, unit price, and GD's burden rate. The first of four cost drivers is the Government's cost associated with a GFE arrangement for the procurement and integration of the MK-44. As a result of a direct contractual relationship with ATK, under a GFE arrangement, the Government will incur labor costs for contract administration and contractor management duties associated with that contract. The Government labor cost is quantifiable and should be included in a cost comparison of GFE and CFE. However, the Government labor cost, in this instance, is unsupportable due to manpower and funding constraints. Available funding does not allow for hiring additional personnel. Therefore, current EFV program personnel would execute the contract administration and management tasks associated with a MK-44 contract as collateral duties. Fundamentally, a GFE arrangement would incorporate, at least on the surface, huge savings because the labor costs are a sunk cost - the personnel assigned to the EFV Program Office would receive their wages and benefits regardless of whether the MK-44 contract with ATK exists or not.

However, there is a cost associated with the work a Government employee is not able to perform as a result of completing tasks associated with an ATK/MK-44 contract. This cost is identified as the opportunity cost of a GFE arrangement. Developing an estimate for this opportunity cost is paramount to deriving a reasonably acceptable cost figure for the Government's labor efforts under a GFE arrangement. Without an estimate for Government labor costs associated with a GFE arrangement, the savings identified under a GFE versus a CFE arrangement will be inflated and unrealistic.

The EFV Program Office conducted a preliminary labor survey in October, 2002, that led to an estimate of 9,000 man-hours per year for administration and management of the MK-44 contract under a GFE arrangement. By assimilating the data from the survey to determine ranks of personnel (predominantly civilian) associated with specific man-hours and utilizing salary rates for various ranks provided by the Naval Center for Cost Analysis, which includes fringe benefits but does not include indirect labor costs and facility costs, a reasonable Government labor cost estimate is possible. (Ref. 8) Realizing the need for this cost element, the EFV Program Office is currently conducting a follow-up business case analysis to determine a valid and reasonable estimate for the opportunity cost of Government labor associated with a GFE arrangement.

The second of four cost drivers under a GFE arrangement is the standard Government overhead rate of 12 percent. The overhead rate is quantifiable, but unsupportable, as the Program Office has not conducted an analysis to determine the validity of the regulatory rate. Additionally, tracking all costs associated with just the MK-44 would be inefficient and impossible for allocation purposes required for typical overhead calculations. The current OMB A-76 studies will provide some background for this cost element.

The OMB Circular A-76 and its supplemental handbook provide policy guidance and implementation procedures for Government agencies to use in deciding whether to contract out for commercial goods, services, and activities. OMB updated this handbook in 1983 and again in March 1996. OMB’s revised A-76 supplemental handbook established or changed several standard cost factors and included the requirement that Government overhead costs be calculated by using a standard rate of 12 percent of direct labor costs. This provided a standard Government overhead rate to use for cost estimates much like those being analyzed in this thesis. The latest revision was intended to reduce the administrative burden of performing A-76 Studies and to make cost comparisons between private sector proposals and Government estimates more equitable. This "best value" private sector offer is then compared to the Government's in-house proposal. (Ref 23)

The fundamental decision to be made by the EFV Program Office is whether the Government will benefit more from acting as the buyer of the MK-44 or from outsourcing the procurement of the MK-44 to GD. In this light, the A-76 mandated overhead rate of 12 percent warrants inclusion as a Government cost factor to accurately compare a GFE (in-house) arrangement to a CFE (outsource) arrangement.

However, validating the 12 percent overhead rate, in the context of the EFV program, is a challenging prospect requiring additional data. Included in this figure are other costs associated with managing the MK-44 contract, to include travel, employee benefits and the cost associated with the infrastructure needed to allow these employees to work. The primary difficulty and one that renders this cost element unsupportable for a GFE arrangement is quantifying the administrative and community costs incurred by current EFV Program Office personnel in a GFE arrangement. The EFV Program Office is currently developing validation criteria to establish an accurate overhead rate in accordance with the guidance from Circular A-76.

The third of four cost drivers associated with a GFE arrangement is the unit price charged by ATK for each MK-44 chain gun. ATK is in the process of establishing a catalogue price for the MK-44. This potentially indicates that the MK-44 unit cost from ATK should be the same, regardless of buyer. The catalogue price has not been determined and the Government has not issued a Request For Proposal (RFP) at this time. A unit cost analysis provides insight concerning the ability of either entity, the Government or GD, to negotiate a lower unit cost from ATK. Variation in negotiated unit cost will have a direct impact on a CFE versus GFE decision.

The ability to negotiate a more favorable unit cost leads to a discussion of Economies of Scale (EOS). EOS occur when the volume of procurement reaches a price break level offered by the contractor resulting in a lower per unit cost. Both the Government and GD have the potential to negotiate an EOS price break in the event another program, such as the USN LPD-17, adds to the EFV's MK-44 requirement for the Government (GFE) or GD is placed under contract by another program with a requirement for the MK-44 (CFE). The EOS analysis is difficult to assimilate due to the inability to predict other program requirements or contractor actions. This thesis will consider this an issue for the EFV Program Office to consider during market research and RFP preparation.

The EOS discussion, from a thesis perspective, will tend to favor GD and a CFE arrangement. The EFV Program Office is not the Program Manager for medium caliber weapons for the USMC, nor is there any funding in the EFV's program to provide for the additional duties this would require. GD, on the other hand, has the resources and industry clout to become involved with other military programs that require the use of the MK-44. A good example is the US Army's new Future Combat System (FCS) line of vehicles where GD is the prime contractor on half of FCS vehicles. GD could possibly have a comparative advantage to negotiate a high volume price break (EOS) for the MK-44 requirement.

The potential for Direct Commercial Sales adds to the comparative advantage of GD to attain EOS. This type of sale allows GD to commercially sell the MK-46 Gun System (nomenclature after MK-44 is integrated with a turret) to any friendly allied nation of the US Government. Interest in procuring the MK-46 Gun System has been expressed by Belgium, Czech Republic, South Korea, and Great Britain. Between the interested countries, potential sales represent approximately 2,600 MK-46 systems. Of note, GD could not provide additional data, only that interest has been expressed by the previously mentioned countries. This issue is a viable cost consideration and should be addressed during contract discussions and negotiation under a CFE arrangement. (Ref 23)

The fourth and final cost driver associated with a GFE arrangement is GD's Burden Rate, which is the rate GD will charge the Government to receive, store and manage the MK-44 until integration with the EFV is complete. The GD Burden Rate is a percentage of the MK-44 unit cost (the unit cost derived from the contract established between the Government and ATK) for each MK-44 received and integrated by GD, as stipulated in the contract between the Government and GD. The GD Burden Rate is designed to cover GD's costs associated with physically receiving, handling and storing a Government owned item, the MK-44.

2. Identification of CFE Cost Drivers

The second set of cost drivers to be identified is unit price, GD's profit rate, and GD's General and Administrative Expense Rate (G&AEx). The first of three cost drivers is the unit price charged by ATK for each MK-44 chain gun. As stipulated in the last section, we believe GD has a greater potential for obtaining a lower unit cost (price) from ATK based on the potential EOS attained through additional government contracts requiring the MK-44 and/or through Direct Commercial Sales of the MK-46 System.

The second of three cost drivers associated with a CFE arrangement is GD's profit rate, which is the rate GD will charge the Government to procure and integrate the MK-44, while managing ATK as a subcontractor. The GD Profit Rate is a percentage of the MK-44 unit cost (the unit cost derived from the sub-contract established between GD and ATK) for each MK-44 procured and integrated with the EFV by GD, as stipulated in the prime contract between the Government and GD.

GD's Profit Rate is the single cost driver with the greatest impact on the total cost of a CFE arrangement. The Profit Rate represents GD's desired increase to their bottom line for each iterative MK-44 integration process. From the Government's perspective, GD's Profit Rate must be justified and off-set by a service provided by GD as the Prime Contractor. GD's service will be comprised of, mostly, activities associated with managing the subcontractor (ATK). Those activities include, but are not limited to, successful integration of the MK-44, proactive management of configuration and integration issues and documentation and timely resolution of technical design and/or performance issues. The stability and history of GD's Profit Rate figures are discussed later in this chapter. The ability of the Government to justify GD's Profit Rate is discussed later in this chapter through discussions of paying a risk insurance premium. Additionally, Chapter VI discusses the necessity of assigning value-added to the services provided by GD under a CFE arrangement. A comparison of GD's Profit Rate dollar value and the value-added estimate provide additional metrics for justifying or deterring a CFE arrangement.

The third and final cost driver associated with a CFE arrangement is G&AEx, which is the rate GD will charge the Government to cover general and administrative expenses associated with managing the contract with ATK. GD's G&AEx Rate is a percentage of the MK-44 unit cost (the unit cost derived from the sub-contract established between GD and ATK) for each MK-44 procured and integrated with the EFV by GD, as stipulated in the prime contract between the Government and GD.

B. HISTORY AND COMPARISON OF COST DRIVERS

To this point we have identified the relevant cost drivers associated with a cost analysis of the two alternatives for procuring and integrating the MK-44 with EFV. We proceed with a discussion of the variability and/or stability of the quantifiable cost drivers previously identified for GFE and CFE arrangements. This discussion does not include the GFE cost drivers determined to be unsupportable in the previous section.

1. History of GFE Cost Drivers

The first of two quantifiable cost drivers associated with a GFE arrangement is the unit price charged by ATK for each MK-44 chain gun. The unit price of a MK-44, based on historical and estimated projections, has a range of values. Data provided by the EFV Program Office from 2000 to 2004 indicates a MK-44 unit price range of $151,750 (2000) to $182,884 (2004). Interviews with EFV Program Office personnel established the most current unit price as adequate for the cost analysis. However, several comments from the interviews indicated a plausible level of uncertainty with ATK's pricing of the MK-44 for different buyers. The contracting process is not at a point of discussions or negotiations to clarify ATK's pricing strategy. Given that a decision to proceed with a GFE or CFE arrangement will be made prior to contract negotiations, the most recent unit price estimate from 2004 is suitable for the cost analysis of both a CFE and GFE arrangement.

The second and final quantifiable cost driver associated with a GFE arrangement is GD's Burden Rate, which is the rate GD will charge the Government, as a percentage of the MK-44 unit price, to receive, store and manage each MK-44 until integration with the EFV is complete. The EFV Program Office procured and integrated the MK-44 with a GFE arrangement in 2000 for the System Design and Development phase of the EFV. At the time GD's Burden Rate for a GFE item was 8%.

Since March 2000, GD has reduced their burden rate for a GFE item having a unit cost greater than $100,000 from 8% to 2%. The available history of GD's Burden Rate for a GFE item with a unit cost greater than $100,000 has varied from a high of 12% to a low of 2%. (Ref 24) The EFV Program Office is satisfied that GD's Burden Rate is stable at a current low of 2%.

Table 1. GFE Arrangement Costs

GFE Arrangement	
MK-44 Unit Price	$182,884
GD's Burden Rate	2 %
Total Cost per MK-44	$186,541

2. History of CFE Cost Drivers

The first of three quantifiable cost drivers associated with a CFE arrangement is the unit price charged by ATK for each MK-44. As stated in the previous section, our research has determined the most recent unit price estimate available from the EFV Program Office will suffice for both GFE and CFE cost analyses and that MK-44 unit price is $182,884.

The second of three quantifiable cost drivers associated with a CFE arrangement is GD's Profit Rate. GD's Profit Rate is negotiated at the time of contract discussions and negotiations. However, GD's Profit Rate has remained stable at 14% during the last four years. This number has been used for budget planning and there is no certainty that GD's Profit Rate will remain at 14%. However, given a CFE arrangement is pursued, it remains unknown whether a lower profit rate or higher profit rate will be negotiated.

The third and final quantifiable cost driver associated with a CFE arrangement is GD's G&AEx Rate. GD's G&AEx Rate is a percentage of the MK-44 unit cost (the unit cost derived from the sub-contract established between GD and ATK) for each MK-44 procured and integrated with the EFV by GD, as stipulated in the prime contract between the Government and GD. GD's G&AEx Rate is 2%. This rate has remained stable over the history of our research (See Appendix B).

Table 2. CFE Arrangement Costs

CFE Arrangement	
MK-44 Unit Price	$182,884
GD's Profit Rate	14 %
GD's G&AEx Rate	2 %
Total Cost per MK-44	$212,145

For additional data on the history of all relevant cost drivers, see Appendix A.

3. Comparison of GFE versus CFE Total Costs

From Tables 1 and 2 and based on the stability of both GD's Burden Rate, under a GFE arrangement, and GD's G&AEx Rate, under a CFE arrangement, the cost driver responsible for the $25,604 difference is GD's Profit Rate under a CFE arrangement. Already explored is the possibility of the Government and GD negotiating different unit costs for the MK-44. To demonstrate the impact of negotiating a lower GD Profit Rate, we have held the MK-44 unit cost constant, under both scenarios, at a level dictated by the most recent data. The fundamental comparison of the two alternatives is focused on what GD's Profit Rate represents to the Government and does that representation justify the $25,604 increase in cost per MK-44. We provide two theories for articulating GD's Profit Rate from the Government's perspective.

Both theories take risk management into consideration. The first theory is the idea that the Government is paying an insurance premium to cover potential risks associated procuring and integrating the MK-44 with the EFV. The Government paying an insurance premium against unknown future risk events is similar to the rationalization used by automobile owners when buying automobile insurance. Assuming an automobile owner has a clean driving record and is 45 years old, the insurance premium they pay depends on the amount of coverage they want in the event of an accident or theft.

Additionally, the premium will be dictated by the type of vehicle and safety features; a Mustang Cobra with no airbags or alarm system will result in a much higher insurance premium then an Aerostar minivan with front and side airbags.

The theory behind the automobile insurance premium is the theory of risk assessment. The insurance premium is a risk premium based on the nature of the unknown future event. With automobile insurance, the degree to which the owner is risk adverse will determine the amount of coverage. The more risk adverse the owner is the greater their desired coverage, the higher the premium they are willing to pay. Furthermore, the type of vehicle and safety features will determine the level of impact (high speed, fatalities, damages) an unknown future event could have. The insurance premium to cover the risk of injury and damages will be greater for a 2005 Mustang Cobra than for a 1996 Aerostar Minivan. The likelihood of the unknown future event occurring is the identical, however the probability of that event occurring is much different.

This risk theory is directly related to the CFE versus GFE analysis. GD's Profit Rate, regardless of the actual number, represents a risk premium similar to the automobile insurance premium. The Government is similar to the auto owner, where GD would be considered comparable to the insurance company. The Government must quantify the level of 'coverage' they want from GD by way of services to perform. This level will then have to be negotiated with GD who will also determine a level that will allow them to mitigate the risk that they will take over with the CFE arrangement and still make a profit. GD will do this by ensuring ATK is managed as a subcontractor and that the MK-44 is integrated with the EFV, regardless of the occurrence of future events that could affect cost, schedule or performance issues.

The second theory developed for articulating the Government's representation of GD's Profit Rate is assessing the value-added by GD under a CFE arrangement. By doing this assessment, the Government will not pay more than the value-added. Fundamentally, this assessment must be completed to discourage GD from charging a risk premium that is greater then the services they will provide. The value-added concept is discussed further in Chapter VI.

Our research indicates that the likelihood of an unknown event occurring is identical with both arrangements. Therefore, the analysis hinges on first, the type and impact of risk associated with GD's integration and management processes and their ability to resolve integration issues in a timely manner (value-added). And secondly, the Government's level of risk aversion must be considered; what risk premium is the Government willing to pay?

The bar charts below demonstrate the difference between what the Government would pay for the MK-44 as GFE compared to the risk premium paid under CFE. The charts below do not take into consideration the opportunity cost associated with a GFE arrangement or the value-added that GD provides with a CFE arrangement.

When looking at the charts there is also no consideration of unit price discounts due to EOS and Learning Curve Theory. These two items need to be looked at further as these could affect the price of the total contract. In addition to these two factors, the EFV Program Office will not be buying all the Mk-44s at one time. This is also an issue that could affect the price of the Mk-44 over the life of the contract. The analysis of how this could affect the price is outside the scope of this project.

To better understand the insurance premium concept, the tables below contain the procurement of the MK-44 broken down by fiscal year. Underneath the fiscal year is the actual quantity of MK-44's the Government plans on buying. The charts have a range of 13 percent to 15 percent, the reasoning for this is to allow the EFV Program Office to conduct scenario analyses and determine the effect the profit rate will have on the overall contract. With the profit rate being negotiable, the Government is in a position where they will be able to affect the overall price of the contract. The Contracting Officer will need to be proactive and aggressive in trying to negotiate a lower profit rate from GD.

It is important to note that the dollar figures in the charts have not been discounted back and are being used with FY '04' dollars. When the CFE cost is broken down it comes out to roughly $25,000 per gun. The highest the Government will pay is in FY 12 when they will buy 111 MK-44s, this will equal a CFE premium of $2,775,000 for the year. These numbers are just the difference in price and do not show the opportunity cost and additional risk GD will assume from the Government. The $25,604, which was the difference between a GFE and CFE purchase price, therefore does not necessarily represent a savings in price. This represents the difference between the cost of a GFE versus CFE arrangement without including the unsupportable aspects related to the opportunity and overhead costs associated with a GFE arrangement. The EFV office will have to subjectively assign a value to these issues in order to analyze what the true difference will be between CFE and GFE.

Table 3. Cost Comparison at 13%

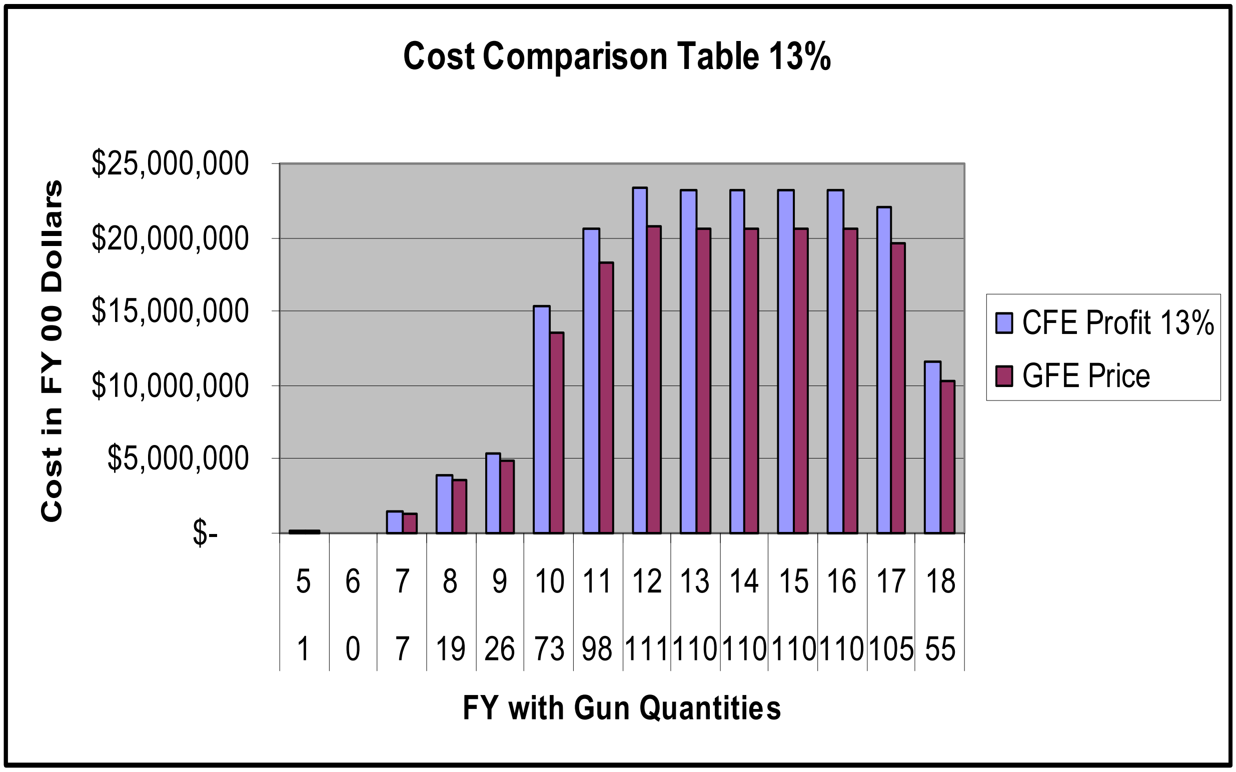


Table 4. Cost Comparison at 14%

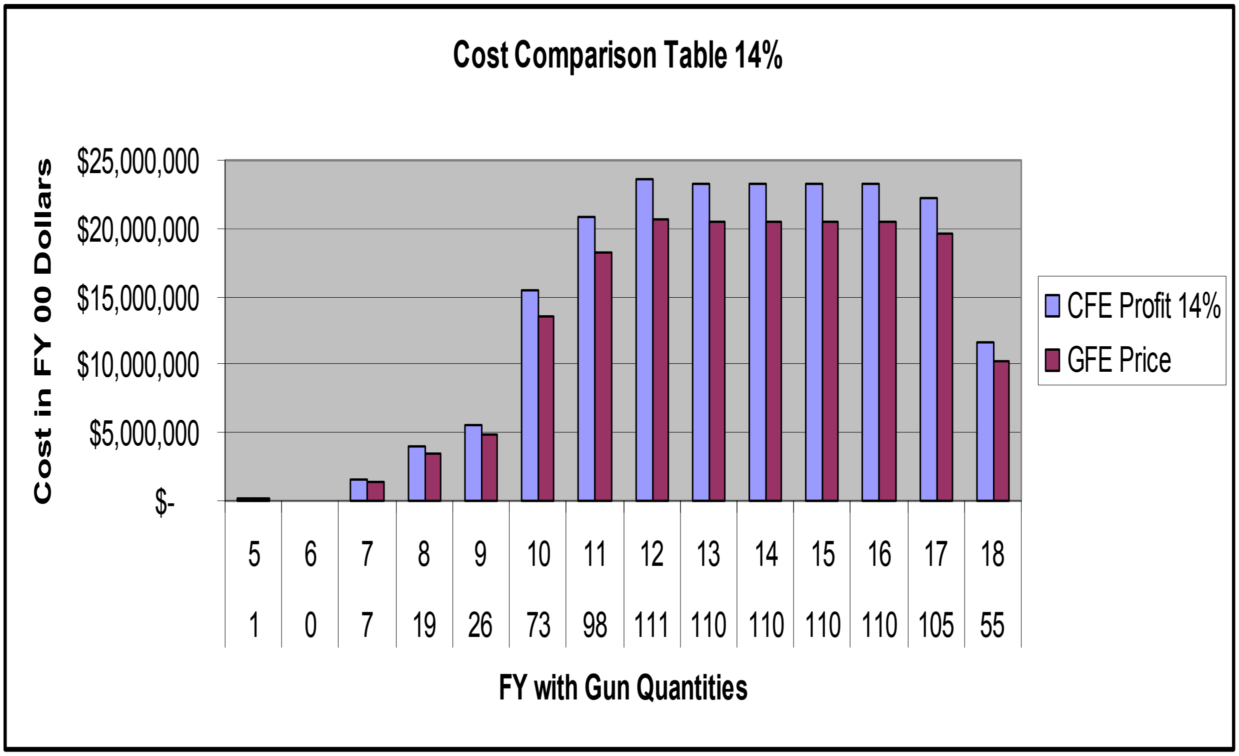
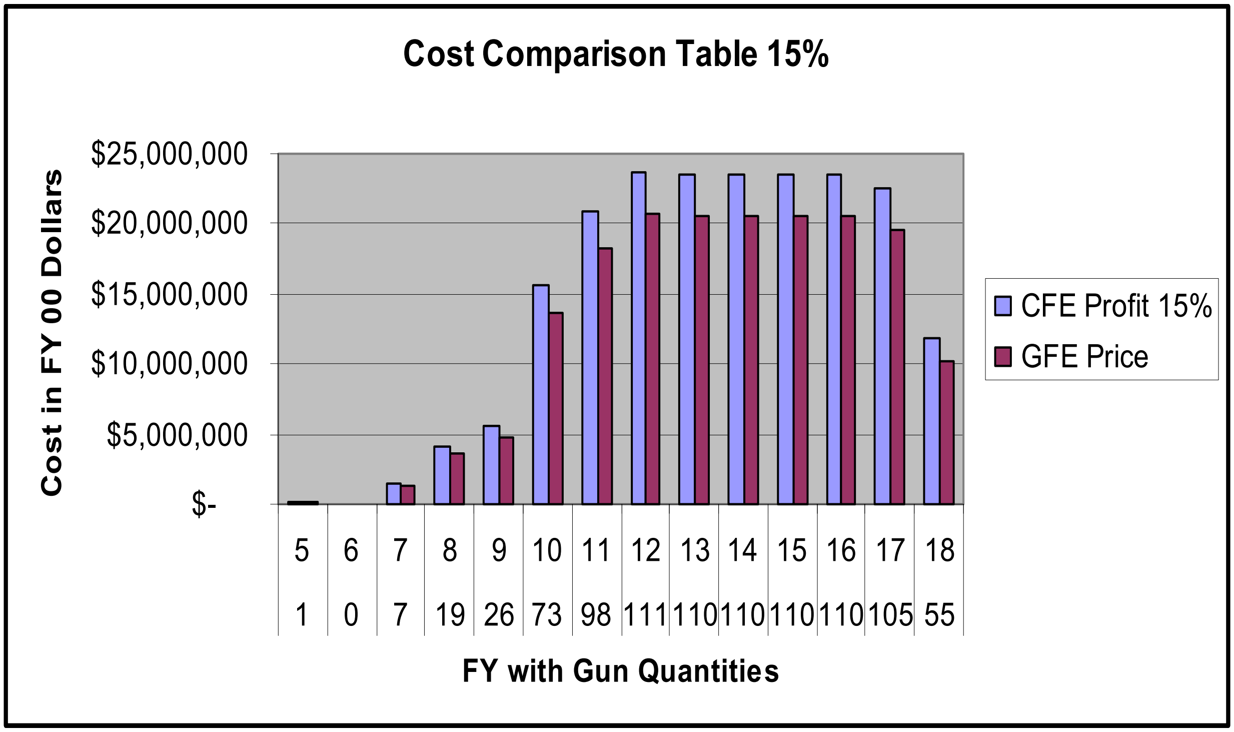


Table 5. Cost Comparison at 15%



C. COST CONTEXT

In determining the context of the MK-44 purchase with the overall price of the EFV, we aim to demonstrate the relationship of this purchase to the overall system acquisition cost. Although the total unit cost of an EFV is not known, for the purpose of this paper the figure $8.5 million will be used as a benchmark. With this being the total cost per EFV, the MK-44 purchase will be approximately 2% of the total cost for each EFV under a GFE arrangement. Additionally, the CFE premium will add a .3% increase in program acquisition costs per EFV. This .3% increase represents the quantifiable value that the Government must compare to the additional services provided by GD under a CFE arrangement. (Ref Appendix C, out-brief to Program Office)

D. CONCLUSION

Throughout this chapter there were three main items that were covered with respect to cost, they were the changing nature of the cost data, the premium which the CFE will require, and cost in relation to the program.

This chapter highlights the issues surrounding the constantly changing cost data. The EFV program management team must be proactive to assimilate the cost data within a fast paced program. The changing cost data puts additional pressure on the management team to make an informed decision in the best interest of the Government.

This paper has referred to the CFE cost as a risk premium that the Government will be charged for services provided by GD. This premium is negotiable with GD and the charts demonstrate various outcomes assisting the Program Office in their determination of when the premium will be in the best interest of the Government.

When looking at the cost of the MK-44 in relation to the purchase price of one EFV and the total life of the program it allows one to examine the overall effect of the MK-44 purchase. This will allow one to examine the entire cost compared to the program costs to determine the size and scope of the contract.

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IV. RISK MANAGEMENT ANALYSIS

A. EFV ACQUISITION PROGRAM RISK DEFINED

Risk is defined as the chance of not achieving the results as planned. Risk is "the probability or likelihood of failing to achieve a particular outcome" and "the consequence or impact of failing to achieve that outcome." Two elements of an event's occurrence, the probability and impact, determine the level of risk and, accordingly, the resources (manpower and funding) required for mitigating, transferring or avoiding the risk. (Ref 26)

This chapter will analyze several areas of risk associated with the EFV Program Office decision to proceed with a GFE or CFE arrangement for procuring and integrating of the MK-44 during Full Rate Production (FRP). In this particular situation, the GFE versus CFE decision will be based, partly, on the degree to which the risk associated with a GFE decision to manage the MK-44 procurement and integration mitigated, avoided or transferred to the prime contractor (GD) under a CFE arrangement.

Fundamental to the risk analysis are the areas of risk related to program cost, schedule, performance, configuration and integration. Each risk area will be broadly identified in the following paragraphs and associated with the MK-44 as a component of the EFV. This chapter will then discuss the risk management tactics of risk mitigation, risk transfer and risk avoidance with an analysis of the options available to the EFV Program Office to implement these tactics under each arrangement.

Program cost risk is the ability of the Program Office to achieve the EFV acquisition cost objectives without experiencing cost overrun. This includes the effects of budget and affordability decisions, such as the GFE versus CFE, and the effects of inherent errors in the cost estimating techniques used, such as the cost estimations of the Government labor and overhead requirement under a GFE arrangement. Additionally, the MK-44 represents only 2% of the EFV's acquisition unit cost and the estimated CFE premium represents .3% of the EFV's unit cost. Therefore, the probability of the MK-44 GFE or CFE decision, in and of itself, resulting in a program cost overrun situation is minimal. However, in the context of this thesis and to adequately assess the options for the EFV Program Office concerning cost issues with respect to the GFE versus CFE decision, the increased cost of a CFE decision must be analyzed. Chapter three provides the details of this cost analysis. What that cost increase represents is paramount to an effective cost-benefit analysis. The cost increase can be considered an "insurance premium" (discussed in Chapter III) against certain risk areas defined below and, accordingly, the probability and impact of those risks occurring. Or the cost difference can be assessed as a "value-added fee", for the additional efforts of GD as the chief integrator, to mitigate and avoid certain risk areas. Either way, the goal of the EFV Program Office is to get the best possible EFV while minimizing program risk at the lowest cost and that includes the cost of the MK-44 procurement and integration.

A GFE arrangement would inherently require additional labor hours, manpower and various other administrative actions, i.e., travel to ATK, direct meetings with ATK, and contract oversight with ATK and GD. Although these add-ons have associated costs, the EFV Program Office considers this particular cost comparison a wash because even with a CFE arrangement, the government will still, to a certain extent, be the whole system coordinator and integrator, to include the MK-44. This position is reiterated in the lessons learned chapter through an interview with the JSF program (Ref 27).

Program schedule risk for a high profile acquisition is always difficult to manage within the often schedule driven acquisition process. The EFV exemplifies the attention an ACAT ID program schedule slip will garner. Fundamentally, with a GFE arrangement between ATK and the Government for the MK-44, the Government is acting as the middle-man and coordinating two contract schedules to ensure production and delivery of the MK-44 coincides with the production of the EFV at GD. Complications in either production schedule will require government coordination efforts with both contractors to ensure production is not halted or inventories are not built up resulting in additional transportation or storage costs. A GFE arrangement increases the risk to the Government and places it in the position of ensuring form, fit and function responsibility for the MK-44 to minimize any schedule complications and cost increases.

MK-44 performance risk is significantly more important under a GFE arrangement. In this case, if the MK-44 is furnished to the prime contractor (GD) in a condition that is not suitable for the intended use, the Government assumes liability and would be forced to correct the problem through modification or redesign coordination with ATK. This could prove to be costly, technically challenging and could definitely impact the program's schedule. (Ref 26)

For example, a small manufacturing glitch by ATK, causing the MK-44 to not have a proper fit with the EFV turret mechanism, constitutes performance risk that must be corrected by the Government under the GFE arrangement. This particular occurrence will lead to the increased probability of occurrence in other risk areas, such as schedule delays and cost increases, while the Government initiates actions to cure the glitch. Under a CFE arrangement, the prime contractor has the responsibility to manage ATK as a subcontractor. GD would assume all schedule and cost risk associated with a missed performance specification. (Ref 23)

Configuration and integration risk is the area of greatest concern. The MK-44 must be integrated with the EFV's turret before it can be considered the operational weapon system of the EFV. Therefore, the slightest variance with respect to form, fit and function of the MK-44 could have disastrous results as GD attempts to integrate it with the turret. If the Government decides to execute a GFE arrangement, the EFV Program Office will be responsible for the system integration risk management plan requiring dedicated resources in the form of technical design expertise to assist with coordinating corrective action. Regardless of the effectiveness of the system integration risk management plan, a GFE arrangement, by way of time and manpower resources required to resolve the integration problem, will result in higher costs than a CFE arrangement.

Configuration management risks are obvious. Any modification, additional capability or re-engineering completed on the MK-44 will have to be fully vetted with the EFV's turret system to ensure form, fit and function. With a GFE arrangement, configuration management resolutions, when two different contractors are involved, can lead to escalating costs and extremely lengthy processes when the modification may, in fact be time sensitive due to mission criticality. The resource burden, similar to integration risk, will be on the Government.

Intangible aspects of risk are not quantifiable, but do merit discussion with respect to what could be lost with a CFE arrangement and must be evaluated by the EFV Program Office to determine their relevance to this analysis. Although the associated risk with a GFE arrangement is disconcerting to a typical PM, being able to have a direct contractual relationship or privity of contract with the two contractors, as would be the case with a GFE arrangement, does provide a certain degree of schedule management and acquisition control. A GFE arrangement would allow the Government to exercise direct contract administration over ATK and GD, thus increasing the PM's insight and knowledge into contract and program progress and potentially improving the likelihood of overall program success. Additionally, the technical risk of the MK-44 is relatively low with respect to the EFV as a whole system. The greatest concern is not whether the MK-44 will technically perform, but how mush risk is associated with the integration process controlled by GD. This point is highlighted in the lessons learned chapter through interviews with the JSF program. (Ref 27)

If the government should decide to execute a CFE arrangement, ATK will become a sub-contractor of GD. Due to the government's privity of contract, GD will control all communication with ATK. The effect of this will cancel a very beneficial relationship with ATK, who has provided the government with ammunition and other technical advice since the initial purchase of the MK-44. (Ref. 30)

Additionally, the EFV Program Office must assess the differences between a CFE and GFE arrangement with respect to the contract management effort required under a GFE arrangement compared to the capabilities and workload of current EFV Program Office personnel. This assessment falls outside the scope of this thesis; however, the subjectivity of the topic lends itself to consideration by the Program Office and staff.

B. EFV PROGRAM RISK MANAGEMENT

There are several tactics available to the EFV Program Office to manage the risks associated with both arrangements. The tactics considered fall into three categories: risk mitigation, risk transfer and risk avoidance.

Risk mitigation is the process that "identifies, evaluates, selects and implements options in order to set objectives." Risk mitigation includes determining what should be done to manage a particular risk, how often it should be done and reported, who is responsible for handling it and what the cost impact of managing the risk is. PM's must determine the possible "consequences of action or inaction as well as conducting a cost-benefit analysis of mitigation actions." (Ref 29)

A CFE decision by the EFV Program Office will result in a single higher cost contract to procure and integrate the MK-44 with the EFV. The risk mitigation process demands that there be value-added by GD's integration process to justify the additional cost. If there is no value-added, the additional cost becomes a pass-through fee and fails to provide a metric for assessing risk mitigation. Additionally, a CFE arrangement assigns the duties of risk management to GD and, with appropriate contract language, can be assessed by the Government over the performance of the contract.

A GFE decision by the EFV Program Office results in two contracts, one with the prime contractor (GD) and another with ATK. A portion of the risk accepted by the Government under a GFE arrangement can be mitigated through contract language and contractual conditions, such as an Associate Contractor Agreement (ACA). The Marine Corps and Navy have successfully implemented a risk mitigation plan in conjunction with a GFE buy for the F-18 E/F program. The engines for the F-18 were procured under GFE through General Electric in Lynn, Massachusetts. The program office mitigated the risks described earlier by using an ACA, which allowed the prime contractor (Boeing) to go and talk directly to General Electric. This cut the government out of the picture and enabled better communication and faster response time.

However, the ACA arrangement was made possible by the government establishing a Defense Contract Field Management Office at GE manned by an administrative contracting officer and placing a program integrator at the GE plant. (Ref. 28)

Risk avoidance constitutes the Program Manager choosing one alternative over another alternative based on the lower level of risk, thereby reducing the risk. However, this does not eliminate the risk. An important distinction to make is that risk avoidance is a conscious decision to choose lower versus higher risk options. Avoiding risk by ignoring its presence and potential impact is an unacceptable solution. The schedule risk associated with potential integration, configuration and design issues becomes the responsibility of the prime contractor under a CFE arrangement.

The EFV Program Office can implement risk avoidance by utilizing a CFE arrangement. The MK-44 CFE arrangement inherently contains less risk for the Government than a GFE arrangement. As indicated, the primary MK-44 risk area is integration and configuration with the EFV turret. GD has a robust resource pool to manage and control integration and configuration risk within the EFV production process. By incorporating GD as chief integrator and sub-contractor manager under a CFE arrangement, the Government will choose the lower risk option.

Risk transfer involves more than one entity sharing risk. This technique is often used between the Government and contractors. The Government may provide financial incentives to a prime contractor to minimize or reduce risks in numerous risk areas, to include system integration, performance and adherence to the program schedule. This is accomplished through financial incentives (award fees, contractual incentives). An award fee provision associated with successful subcontract management would provide an entry point for overseeing the subcontract management function since that insight would be required to adequately assess subcontract management as part of the award fee process. Regardless of arrangement, the idea of sharing risk (in general) is pervasive throughout DoD. The government is accepting a portion of the risk by allowing the contractor to increase their profits through performance awards. The key to the government's ability to enforce schedule and cost constraints is to incentivize the contractor's performance to increase their profit.

The Government's contract with GD may include incentives that emphasize successful performance as chief integrator and configuration manager. The Government's primary means of influencing the degree to which a CFE arrangement reduces their risk exposure is through proactive contract language that holds GD, as the prime contractor, responsible and accountable for potential integration and configuration issues. Additionally, under a CFE arrangement GD may be incentivized by rewarding effective subcontractor management. The proactive contract language, combined with financial incentives, will allow the Government to adequately transfer and share the program risk associated with a CFE arrangement.

Another method of risk transfer available to the EFV Program Office, under a GFE arrangement, is the Integrated Product Team (IPT) Management technique referenced in the JSF program interview. (Ref 27) The IPT Management structure would assign GD the leadership role of the IPTs associated with the MK-44 component of the EFV. This assignment ensures GD has knowledge of day-to-day issues involving the MK-44 performance, integration and configuration. With this knowledge, GD, under a GFE arrangement, will be more proactive and diligent in managing risk issues as they arise.

The flip side of the IPT Management technique is the potential of the Government relinquishing greater control to GD by assigning GD personnel as IPT leads. The Government is able to reduce this potential problem by assigning IPT members with appropriate knowledge and experience to ensure a GD led IPT doesn't evolve into a run away train.

Additionally, and probably more difficult, the Government should assign IPT members who will provide consistent and reliable input to the IPT and feedback to the Government. The Government, to manage the risk associated with a GFE arrangement, should avoid managing the MK-44 procurement and integration "by committee". EFV Program Office personnel roles should be clearly defined under a GFE arrangement, vice a collateral duty for the "most available" individual.

C. CONCLUSION

The EFV Program Office's risk management plan will be extensive and should be well thought out with respect to those intangible areas identified in this chapter. The subjectivity of the intangible areas makes their relevance and importance undeterminable for this analysis. However, based on the remaining criteria for determining an effective risk management plan, a CFE arrangement will provide the lowest risk option with the greatest flexibility to proactively mitigate and reduce the occurrence and impact of potential issues associated with cost, schedule, performance and integration/configuration.

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V. LESSONS LEARNED FROM MAJOR DOD PROGRAMS

A. INTRODUCTION

This chapter provides insights from various DoD programs that have successfully, thus far, analyzed the GFE and CFE arrangements for procurement and integration decisions. The first program is the US Army Aviation Command's (USAAC) Apache Block III program. The Apache's 30MM chain gun is also manufactured by ATK and has been integrated under a CFE arrangement with the prime contractor, Boeing Corporation. The second program will be the Joint Strike Fighter (JSF). The key parallel between the JSF program and this thesis is how they procure and integrate the engine. Although the physical comparison of an aircraft engine to the MK-44 is not completely accurate, the thought processes and determining factors of the program office making the ultimate decision to incorporate a GFE arrangement for the aircraft engine is germane to our analysis of the MK-44 procurement.

B. APACHE BLOCK III PROGRAM

An interview with Lieutenant Colonel Vince Tobin, the PM of the Apache Block III upgrade for the USAAC Apache Longbow Attack Helicopter highlighted multiple aspects of an effective GFE versus CFE analysis that proved valuable to this thesis. The opportunity was also presented to interview the Senior PM for Boeing Corporation (the prime contractor), Mr. Robert Kelly, to gain insight for our analysis from a prime contractor's perspective.

1. Apache Block III and a GFE Arrangement

The most difficult aspect of a GFE/CFE analysis, from the author's perspective, is assessing the risk associated with each arrangement and quantifying that risk as a cost or schedule driver. This task is difficult simply due to the unique considerations of the Government (non-profit) arena discussed in Chapter IV. LTC Tobin described the task of translating risk into a measurable cost driver as absolutely necessary for an adequate comparison of the two arrangements. The reasoning behind deriving a cost driver associated with various types of program risk is straight forward; with a GFE arrangement the entire burden of risk management for schedule, performance, and configuration management among other risks associated with the MK-44 rests solely with the Government. LTC Tobin illustrated with an example from the Apache's Inertial Navigation System. This system, originally procured and integrated under a GFE arrangement, was applied to the Apache Longbow under the prime contractor, Boeing Corporation. According to LTC Tobin, whenever there was a problem with a software load on the Apache Longbow during testing, Boeing initially held the GFE (Inertial Navigation System) responsible for the software failure. As a result of the GFE arrangement, the initial claim by Boeing required the Government engineers to refute the claim through additional research and testing at a tremendous cost in both program time and funding. This process of fault determination, vice problem solving, created friction between the Government and the contractor increasing the risk of both cost and schedule overrun.

Lesson Learned: A GFE decision by the Government requires a systematic plan to mitigate the potential risks associated with this arrangement. The Government must have the engineering and personnel support necessary to refute false claims of faulty GFE performance or resolve true claims of faulty GFE performance. Both situations will add to the task of managing and mitigating schedule risk, while the former will have an additional impact on budget risk. LTC Tobin noted an interesting question, "It may be cheaper to acquire the product GFE but is it cheaper in the long run when the weapon system comes out the door, maintaining it and taking care of it?" (Ref 20)

2. Apache Block III and a CFE Arrangement

The Apache Block III program decided to procure and integrate the 30MM gun as CFE. This particular decision provided real world benefits to combat forces during Desert Storm. The US Army had a requirement to increase the fuel capacity of the Apache to provide greater range and loiter time. The decision was made to replace a portion of the ammunition storage with greater gas tank capacity. Due to the sensitivity of aircraft weight shifts and balance, implementing this engineering change proposal was a significant undertaking. The CFE arrangement facilitated the successful modification in a time critical, real world scenario. The Government only had to work with Boeing; Boeing had the engineering support, control of all past configuration efforts, owned all past design specifications and utilized ATK as a sub-contractor.

Lesson Learned: In today's world of uncertainty and changing requirements for military capability, a CFE arrangement provides additional flexibility when the improbable requirement is time sensitive and mission critical. The Government must take this into consideration as they analyze a decision to implement a CFE or GFE arrangement. A CFE arrangement has the potential to develop multiple solutions at a lower cost and under a constrained timetable.

3. CFE Negative Implications

LTC Tobin provided a fair and balanced assessment of a CFE arrangement in that this arrangement is not the perfect answer. An issue of concern is that Boeing, under the CFE arrangement, owns the system, including the 30MM gun. Consequently, the US Army must get a Justification and Approval for a sole source to Boeing whenever they have a modification or change proposal on the system. This can give the contractor leverage knowing that the Government has to go to them; this can create a tendency for the contractor to be expensive. There is value added in CFE, the Government needs to hold the contractor responsible for ensuring the system operates properly in this environment.

4. Configuration and Communication Control

The Apache Longbow 30MM gun CFE arrangement has resulted in a significant issue concerning configuration control for the program office. Configuration control of the 30MM gun was contracted to Boeing as part of the primary contract.

The US Army unilaterally modified the 30MM gun on the Block I Apache. Those Block I Apaches are scheduled for the Block III upgrade by Boeing. The unilateral modifications are not proprietary to Boeing, therefore, the 30MM gun configuration Boeing expects to receive for the Block III upgrade is different from the modified 30MM gun configuration that is actually on the Apache. Contractually, Boeing is the configuration control manager and will only apply the Block III upgrade to their 30MM gun configuration. Consequently, Boeing will have to strip the modified 30MM gun to the original Boeing configuration to apply the Block III upgrade. Boeing will charge all costs associated with this effort to the Government and require additional time to complete the Block III upgrade.

The Government's desire to have the unilateral modifications integrated with the Apache Longbow during the Block III upgrade is agreeable with Boeing. But it will come at a cost in both time and funding to update all engineering and configuration management documents.

Lesson Learned: If the Government decides to designate the contractor as the configuration manager it must be aware that modifications and configuration updates must be implemented by the contractor and additional funding might be required for future situations. Furthermore, designating the contractor as the configuration manager authorizes the contractor to veto the Government on decisions concerning the CFE. For example, Boeing is now in a position to veto the Government's request to update and modify the configuration by saying they are not able to engineer that particular equipment or are not capable of integrating that feature. This needs to be identified as a potential Government issue with a CFE arrangement.

5. Sub-Contractor Management

According to Mr. Kelly, communication between Boeing and ATK has been positive and, with Boeing's ability to effectively manage ATK as a sub-contractor, the above issue has been resolved. Because ATK is now a Boeing sub-contractor, there have been no issues with this situation. Of note, Boeing had previously owned ATK and those established relationships provide some explanation for the "very positive working relationship" that currently exists between Boeing and ATK. LTC Tobin concurred that the US Army had not encountered any problems with ATK being a sub-contractor to Boeing. In fact, LTC Tobin indicated that Boeing is far better staffed and equipped than the Government to manage ATK. He noted that contractors are able to take advantage of Enterprise Resource Planning systems and other tools of this nature.

6. Apache Conclusion

The question was asked if LTC Tobin had to do it all over again how would he purchase the gun. He responded that he would use CFE again. He stated he had no analysis to back this up but he felt that, most of the time, the benefits of CFE outweigh the costs. The risks that are incurred with GFE that are not easily identifiable need to be considered. He also stated that if the Government makes the decision to use GFE they need to keep their eyes open because the burden is on the Government. This burden includes the extra engineering and the additional oversight required to manage situations. (Refs. 20 and 21)

C. JSF PROGRAM

The interview with Stony MacAdams, the Propulsion Acquisition Manager for the JSF over the past four years, provided experience oriented insights for an effective GFE versus CFE analysis. The JSF Program Office has a GFE arrangement with Pratt Witney and GE/Rolls Royce to provide the JSF engine to Lockheed Martin, the prime contractor for the JSF.

1. JSF Program Maintains "System" View

The JSF program procures the engine through a GFE arrangement with the "engine guys" (PW and GE). The engine is provided to the "plane guys" (LHM) for integration. Mr. MacAdams used these terms to establish the idea that under a CFE arrangement, and in situations requiring modifications or configuration changes as a result of operational testing and evaluation, the "plane guys" may not have a system approach to assessing subject modifications. For instance, if the JSF had reported power issues during take-off, the "plane guys" could simply present the power issue to the "engine guys" (transferring the risk) with direction to fix the engine when engine output is already maximized. The more prudent approach to a perceived power issue would be to assess the entire system. This would include determining if weight distribution is incorrect or the aircraft weight is outside of specifications due to ordnance or fuel load. There may be other factors contributing to a perceived power issue that may have system implications.

Mr. MacAdams' point is that the program office is the entity with a true "system" view of the JSF and a GFE arrangement with the "engine guys" will prevent the prime contractor or "plane guys" from making decisions without the benefit of a whole system analysis. Additionally, the JSF engine is a key subsystem representing a high level of technical risk and a majority of program cost, warranting the GFE arrangement.

Lesson Learned: The continuing increase in the complexity of acquisition programs guarantees a PM will have to work with multiple large contractors to provide the desired product at the end of the acquisition process. The PM must evaluate the inherent risk and scope of a particular subsystem. The PM must then determine whether that subsystem should be procured with a GFE or CFE arrangement depending on several variables, one of which is the PM's ability to effectively manage the whole system through the acquisition cycle.

2. JSF Program Integrated Product Team (IPT) Management Structure

Mr. MacAdams provided some insights concerning the negative perception of GFE arrangements within the program office. To combat this perception he ceased using the term GFE and addressed the arrangement as an IPT Management Structure. Within this structure, each subsystem has an IPT and LHM or the prime contractor has the IPT lead in all cases, regardless of GFE or CFE status. This reinforces the contractual requirement that LHM perform duties as primary integrator responsible for all subsystem interfaces and performance. The IPT structure ensures that the prime contractor or their representative is involved with day-to-day subsystem issues. This structure mitigates the risk that prime contractors will claim non-performance against a GFE subsystem contractor. The prime contractor is aware of all integration, configuration and performance issues through the IPTs.

Lesson Learned: The government has the ability to delegate and empower the prime contractor as the chief integrator of all subsystems. This can be accomplished whether a subsystem is procured with a GFE or CFE arrangement, with the CFE arrangement making this delegation more automatic and less reliant on effective contract language and administration. Using IPTs is already the norm for most program offices. However, ensuring the prime contractor has the lead on all IPTs is more the exception. With a succinct, detailed and appropriately incentivized contract, the prime contractor/chief integrator should request the lead position on all IPTs.

3. JSF Program and GFE vs CFE

Mr. MacAdams provided the perspective of a seasoned acquisition professional concerning when he would utilize a CFE arrangement. According to Mr. MacAdams, "Do CFE when there is value added by them (the prime contractor) doing the work." The government is going to pay a premium to the prime contractor under a CFE arrangement regardless of subsystem or contractor. According to MacAdams, that premium should be considered a fee for value added performance. If there is no value added resulting from the CFE arrangement, the government is paying the prime contractor pass through fees or non-value added costs. The idea of transferring risk to the prime contractor is incorrect. First, a solid contract is more than capable of ensuring a level of risk mitigation is established from the beginning. Secondly, government acquisition professionals operate in a predominantly cost-reimbursement contract environment. This ensures the government accepts the risk of schedule slips and cost overruns regardless of CFE or GFE arrangements.

When asked about using a GFE arrangement, MacAdams indicated that when DoD has the manpower base and infrastructure to support a particular subsystem development and production, along with a history of such performance, a GFE arrangement makes the most sense. In this case, MacAdams is referring to the jet aircraft engine technical and design expertise resident in DoD along with a long history of successful engine programs.

Lesson Learned: The government must identify and quantify the value added that offsets the premium required by a prime contractor under a CFE arrangement. If there is no value added by the prime contractor, the PM will be hard pressed to justify paying a premium for the CFE arrangement. Additionally, the PM must be aware of the type of contract instrument and contract language being used to determine the actual risk a CFE arrangement would transfer from the government to the prime contractor.

The PM must be aware of internal technical, design and support expertise available for a particular subsystem. The PM must determine if that expertise is adequate for the GFE arrangement. The PM should review available history on similar subsystem procurements and evaluate specific trends or issues relevant to their program.

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VI. CONCLUSION

A. INTRODUCTION

The primary objective of this thesis was to examine what decisions and types of analysis should be made when confronted with a multiple contractor acquisition and integration issue such as GFE versus CFE. The secondary objective was to educate and create a document of lessons learned that will help future Program Managers (PM) be able to better analyze the correct approach to deciding whether to purchase GFE or CFE.

The research effort began with a background of the EFV program and the history behind the program. The next item of discussion was the effect of cost on the decision making process with a GFE or CFE arrangement. The cost analysis was followed by how an effective and proactive risk management plan would impact the decision. The final discussion point aimed at gaining insight from current acquisition programs to include the US Army Apache program and the Joint Strike Fighter Program. The conclusions from this research are contained below.

B. CONCLUSION

The primary research question focuses on whether the procurement and integration of the MK-44 is more advantageous to the Government under a GFE or CFE arrangement?

In the end, the cost-benefit analysis for the EFV Program Office will be a comparison between the GD "insurance premium" (in addition to contract performance incentives) equal to the MK-44 cost increase under a CFE arrangement versus the benefit or value-added by GD as the prime contractor under a CFE arrangement. Fundamentally, the government must have value-added to the EFV acquisition process to justify paying GD a 14% premium to manage ATK as a subcontractor.

One of our secondary research questions aimed at determining if there are certain characteristics of a component or subsystem that would inherently lead a PM to execute a CFE or GFE arrangement. From our discussions with other DoD Acquisition Program Officials experienced in utilizing both types of arrangements, we have developed five fundamental characteristics that will objectively lead to either a CFE or GFE arrangement. Not developed are the more subjective issues a PM must account for in making this decision – reflecting that DoD acquisition is more of an art than a science.

The first characteristic is the level of technical risk associated with the subsystem or component. The lower the technical risk, the less likely that a PM would feel the need to be directly involved with the design, development or production. This is particularly true of a commercial item as opposed to a government developmental item. In this case, the hands-off approach would facilitate a CFE arrangement. The opposite holds when a component or subsystem with a high level of technical risk demands a more hands-on approach by the PM, particularly if the component or subsystem holds the majority of the "program's" technical risk. In this case, the PM will lean towards a GFE arrangement to ensure that appropriate awareness and risk management efforts are executed. The MK-44 falls in the low technical risk category that should lend it to the CFE arraignment.

The second characteristic is the cost of the component or subsystem, as a proportion of total program cost. The lower the unit cost, the less effort required on the part of the PM to manage and control the cost. Additionally, a CFE arrangement increases the cost for the component or subsystem. The lower the original unit cost, the lower the cost increase for a CFE arrangement. The PM will be able to justify the additional cost of a CFE arrangement with greater conviction. The higher the unit cost, the harder it is to justify the cost increase for a CFE arrangement. The MK-44 lends itself to a CFE arrangement with a component acquisition cost of just 2% of the EFV unit cost and a predictable CFE premium equal to .3% of the EFV unit cost.

The third characteristic is the maturity of the contractor and its production processes. The more reliable, consistent and mature a contractor's production processes for a particular item, the more likely that item is to be considered for a CFE arrangement. If there are unresolved issues or inconsistencies with an unproven product or contractor, the PM will most likely insist on a direct relationship with the contractor to ensure positive control and risk management. The EFV Program Office considers ATK's MK-44 production capability to be a mature process resulting in a reliable product.

Additionally, our research interview with the Apache Program Office indicated ATK received favorable remarks as a mature, responsive subcontractor. Therefore, the MK-44 acquisition would be best suited to a CFE arrangement.

The fourth characteristic is whether the particular item is sole sourced or competed. A competed item may allow the Government to negotiate a lower cost contract under a GFE arrangement, while a sole source item will be contracted at the same cost regardless of whether there is a CFE or GFE arrangement assuming the Government and Prime Contractor have similar bargaining powers. The exception to this is the ability of one party (Government or prime contractor) to achieve economies of scale (EOS) through a high volume procurement. This determination would hinge on the probability of one party or the other being able to garner such EOS. Unless such arrangements already exist and are advertised, this assessment is difficult for two reasons. First, it demands looking into the future, a perspective not common in the DoD acquisition community. Second, this assessment depends on knowing the business plans of two commercial organizations operating for profit. Determining the ability of one company to achieve EOS and the degree to which another will allow EOS is difficult and unreliable. Barring particular arrangements identifying EOS one way or the other, a sole sourced item is not a reasonable factor for determining which arrangement will be more favorable in every instance. The MK-44 is a sole sourced item, however, according to EFV Program Office personnel, there is uncertainty underlying the assignment of a unit price under a CFE arrangement. In this instance, the Government is not clear that this particular sole sourced item will have a similar unit price under the two arrangements.

The fifth characteristic is determining whether there is value-added as a result of a CFE arrangement. This determination depends on how the item in question is viewed relative to the whole system. Given the first four characteristics are identified in a particular item, i.e. the item is sole sourced, has a low level of technical risk with a low cost share relative to the whole system and the contractor/item is proven with a mature, reliable production process, in order to utilize CFE arrangement, the prime contractor must provide value-added processes to offset the additional cost. More often than not, the value-added processes will come from the prime contractor's function as chief integrator. The prime contractor's ability to consistently and flawlessly integrate the potential CFE item with the whole system will determine the value-added. The key to the value-added determination is the extent to which a particular item requires considerable integration processes and encompasses a high degree of integration risk.

For example, a potential CFE item may require assembly with two bolts and nuts tightened to a specific torque. That situation would encompass little risk with few processes and would be difficult to determine a value-added commensurate with the additional cost of the CFE arrangement. However, if the item has more detailed assembly processes or software integration processes requiring minimal variation and encompassing a higher degree of integration risk, the value-added by the prime contractor implementing positive control over integration will be worth the additional cost of a CFE arrangement. The MK-44's current integration falls near the center of a integration complexity scale with multiple software interfaces on one end of the spectrum and the previously mentioned bolt and nut integration on the other end of the spectrum. The caveat for the MK-44, making the value-added processes more beneficial and in-line with the CFE premium, is the potential for future interoperable and upgradeable capabilities.

There are also the subjective considerations that must be evaluated by the program office. The last contact with the Program Office indicated that these subjective areas are currently being evaluated. Their intent is to subsume what we have developed quantifiably and incorporate their findings to produce a business case analysis for the EFV Program Office.

The key findings of our research indicate the MK-44 procurement and integration processes should be executed under a CFE arrangement for two primary reasons. First, GD is capable of and, as the prime contractor and chief integrator, will provide value-added processes commensurate with providing the Government a reliable EFV. Secondly, an evaluation of a potential risk management plan indicates the Government will be selecting the lower risk option, with respect to the procurement and integration of the MK-44, by incorporating a CFE arrangement.

C. AREAS FOR FURTHER RESEARCH

As a result of this research effort, the researchers have identified some areas for further research. First, if the USMC (EFV) goes with a CFE arrangement and the US

Navy (LPD 17) procures the MK-44 under a GFE arrangement, GD will be the configuration manager for the USMC, while the Navy will manage their configuration in-house. As EFV's become cargo for the LPD 17, the potential for MK-44 parts to be interchanged does exist. In the event of an accident as a result of parts being interchanged or accountability and maintainability with interchangeable parts, the investigation process could become intertwined with two different configuration managers.

The second item for further research is the establishment of a service wide overhead rate to be used for A-76 studies to determine an appropriate opportunity cost for the Government. The A-76 documentation used for research promulgated the concept of using a 12% overhead rate across the board (DoD wide). However, the A-76 regulation further stipulated that each service is authorized to develop its own justifiable estimate for an overhead rate. Thus far, there does not seem to be any evidence that the USMC has established such a figure.

The third issue for further research would be to determine the plausible benefit to the DoD of establishing a medium caliber weapon system Program Manager to consolidate and procure all medium caliber requirements. Our research seems to indicate a requirement from across the services for medium caliber weaponry. One of our considerations was the ability of the Government to establish EOS with a selected contractor based on high volume requirements. A medium caliber program office may be able to take advantage of EOS more readily than individual programs. This would not be unprecedented. There are small caliber and artillery/tank program offices to consolidate requirements for that specific weaponry.

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APPENDIX A: HISTORY OF BURDEN RATES

Jul-01			
WBS/CES Description	**Unique ID**	**Forecast**	**Equation / Throughput**
** GDAMS MAKE/BUY **			
Material Burden	matlBurden	138.97%	((1+OH) * (1+G&A) * (1+Fee) + (1+OH) * (1*COM))
Material Burden for items exceeding $100,000	matlBurdenEx	117.42%	((1+G&AEx) * (1+Fee))
Material Overhead	GDAMSMOH	4.37%	0.0437
Cost of Money	GDAMSCOM	0.97%	0.0097
Material Related Overhead Rate	OH	8.00%	0.08
G&A Rate	G&A	12.00%	0.12
G&A Rate on items over $100k	G&AEx	3.00%	0.03
Profit Percentage	Fee	14.00%	0.14
Cost of Money	COM	1.00%	0.01
Other Direct Costs Rate	ODC	106.45%	1
WBS/CES Description	**Unique ID**	**Forecast**	**Equation / Throughput**
Primary Weapon (Cannon)		$201,126.76	
MK44 Cannon Mod 1		$186,381.00	
30MM Gun Control UnitMK44 Cannon Mod 1		$9,700.00	
Borescope		$518.00	
Rod, Section, Cleaning		$16.50	
Rod, Section, Cleaning		$14.66	
Handle Assembly		$62.88	
Handl Control Unit		$4,433.72	
Integral Gun Mount		$21,169.60	
Secondary Weapon (Coaxial Machine Gun)			
M240 (7.62MM)		$5,344.00	
Support Equipment		$0.00	
Special Tools			
Jul-02			
WBS/CES Description	**Unique ID**	**Forecast**	**Equation / Throughput**
** GDAMS MAKE/BUY **			
Material Burden	matlBurden	139.00%	((1+MRO) * (1+G&A) * (1+Fee) + (1+MRO) * (1*COM))
Material Burden for items exceeding $100,000	matlBurdenEx	117.00%	((1+G&AEx) * (1+Fee))
Material Burden on GFE	matlBurdenGFE	11.00%	0.11
Cost of Money	GDAMSCOM	1.00%	0.01
Material Related Overhead Rate	MRO	8.00%	0.08
G&A Rate	G&A	12.00%	0.1192

MAEI-Major End-Item Rate ($100k)	G&AEx	3.00%	0.03
Profit Percentage	Fee	14.00%	0.14
Cost of Money	COM	1.00%	0.0097
ARMAMENT (P) GFE		$209,599.67	
Primary Weapon (Cannon)	Cannon	$197,959.41	
MK44 Cannon Mod 1		$183,445.87	[Cost Throughput]
30MM Gun Control UnitMK44 Cannon Mod 1		$9,547.24	[Cost Throughput]
Borescope		$509.84	[Cost Throughput]
Rod, Section, Cleaning		$16.24	[Cost Throughput]
Rod, Section, Cleaning		$14.43	[Cost Throughput]
Handle Assembly		$61.89	[Cost Throughput]
Handl Control Unit		$4,363.90	[Cost Throughput]
Support Equipment		$3,552.95	[Cost Throughput]
Special Tools		$2,827.46	[Cost Throughput]
Dec-02			
WBS/CES Description	**Unique ID**	**Forecast**	**Equation / Throughput**
** GDAMS MAKE/BUY **			
Material Burden	matlBurden	139.00%	((1+MRO) * (1+G&A) * (1+Fee) + (1+MRO) * (1*COM))
Material Burden for items exceeding $100,000	matlBurdenEx	117.00%	((1+G&AEx) * (1+Fee))
Material Burden on GFE	matlBurdenGFE	11.00%	0.11
Cost of Money	GDAMSCOM	1.00%	0.01
Computer Rate	Computer	1268.00%	12.68
Material Related Overhead Rate	MRO	8.00%	0.08
G&A Rate	G&A	12.00%	0.1192
MAEI-Major End-Item Rate ($100k)	G&AEx	3.00%	0.03
Profit Percentage	Fee	14.00%	0.14
Cost of Money	COM	1.00%	0.0097
% Direct which is Support Hours	SH	30.00%	0.3
Other Direct Costs Rate	ODC	107.00%	1
ARMAMENT (P) GFE		$189,546.85	
Primary Weapon (Cannon)	Cannon	$182,884.09	
MK44 Cannon Mod 1		$182,884.09	[Cost Throughput]
Jul-03			
WBS/CES Description	**Unique ID**	**Forecast**	**Equation / Throughput**
** GDAMS MAKE/BUY **			

Material Burden	matlBurden	139.00%	((1+MRO) * (1+G&A) * (1+Fee) + (1+MRO) * (1*COM))
Material Burden for items exceeding $100,000	matlBurdenEx	117.00%	((1+G&AEx) * (1+Fee))
Material Burden on GFE	matlBurdenGFE	11.00%	0.11
Cost of Money	GDAMSCOM	1.00%	0.01
Material Related Overhead Rate	MRO	8.00%	0.08
G&A Rate	G&A	12.00%	0.1192
MAEI-Major End-Item Rate ($100k)	G&AEx	3.00%	0.03
Profit Percentage	Fee	14.00%	0.14
Cost of Money	COM	1.00%	0.0097
Other Direct Costs Rate	ODC	107.00%	1
ARMAMENT (P) GFE		$189,606.34	
Primary Weapon (Cannon)	Cannon	$182,884.09	
MK44 Cannon Mod 1		$182,884.09	
Dec-03			
WBS/CES Description	**Unique ID**	**Forecast**	**Equation / Throughput**
** GDAMS MAKE/BUY **			
Material Burden	matlBurden	134.00%	((1+MRO) * (1+G&A) * (1+Fee) + (1+MRO) * (1*COM))
Material Burden for items exceeding $100,000	matlBurdenEx	116.00%	((1+G&AEx) * (1+Fee))
Material Burden on GFE	matlBurdenGFE	8.00%	0.0806
Cost of Money	GDAMSCOM	1.00%	0.0053
Material Related Overhead Rate	MRO	8.00%	0.0799
G&A Rate	G&A	8.00%	0.0806
MAEI-Major End-Item Rate ($100k)	G&AEx	2.00%	0.0208
Profit Percentage	Fee	14.00%	0.14
Cost of Money	COM	1.00%	0.0053
Other Direct Costs Rate	ODC	107.00%	1
ARMAMENT (P) GFE		$189,606.34	
Primary Weapon (Cannon)	Cannon	$182,884.09	
MK44 Cannon Mod 1		$182,884.09	[Cost Throughput]
May-04			
WBS/CES Description	**Unique ID**	**Forecast**	**Equation / Throughput**
** GDAMS MAKE/BUY **			
Material Burden	matlBurden	132.70%	((1+MRO) * (1+G&A) * (1+Fee) + (1+MRO) * (1*COM))
Material Burden for items exceeding $100,000	matlBurdenEx	116.30%	((1+G&AEx) * (1+Fee))
Material Burden on GFE	matlBurdenGFE	7.00%	0.0698

Cost of Money	GDAMSCOM	0.50%	0.0053
Material Related Overhead Rate	MRO	8.00%	0.0799
G&A Rate	G&A	7.30%	0.07322
MAEI-Major End-Item Rate ($100k)	G&AEx	2.00%	0.02016
Profit Percentage	Fee	14.00%	0.14
Cost of Money	COM	0.50%	0.0053
Other Direct Costs Rate	ODC	106.90%	1
ARMAMENT (P) GFE		$189,606.34	
Primary Weapon (Cannon)	Cannon	$182,884.09	
MK44 Cannon Mod 1		$182,884.09	[Cost Throughput]

APPENDIX B: GENERAL DYNAMICS MATERIAL BURDEN RATES

GFE	Actuals				N/A	Estimated				
Cost burden factor	CY99	CY00	CY01	CY02	CY03	CY04	CY05	CY06	CY07	CY08
Unit cost more than $100,000	0.03	0.03	0.03	0.02	N/A	0.02	0.02	0.02	0.02	0.02
GD Supply	Actuals				N/A	Estimated				
Cost burden factor	CY99	CY00	CY01	CY02	CY03	CY04	CY05	CY06	CY07	CY08
Unit cost more than $100,000	0.03	0.03	0.03	0.02	N/A	0.02	0.02	0.02	0.02	0.02

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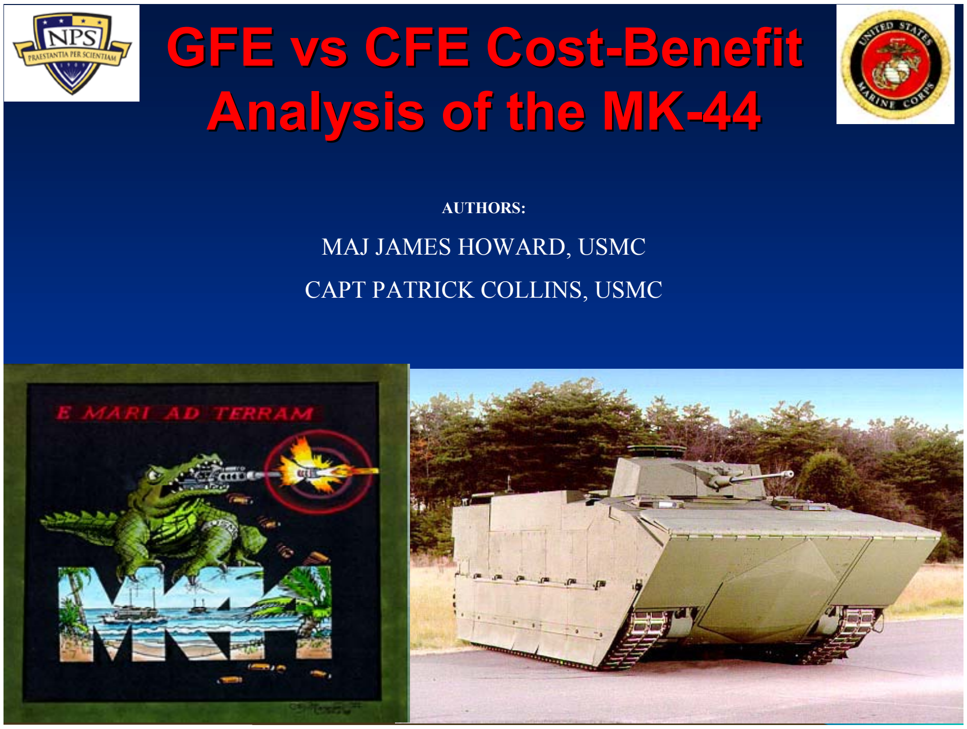
APPENDIX C: OUTBRIEF TO EFV PROGRAM OFFICE



GFE vs CFE Cost-Benefit Analysis of the MK-44

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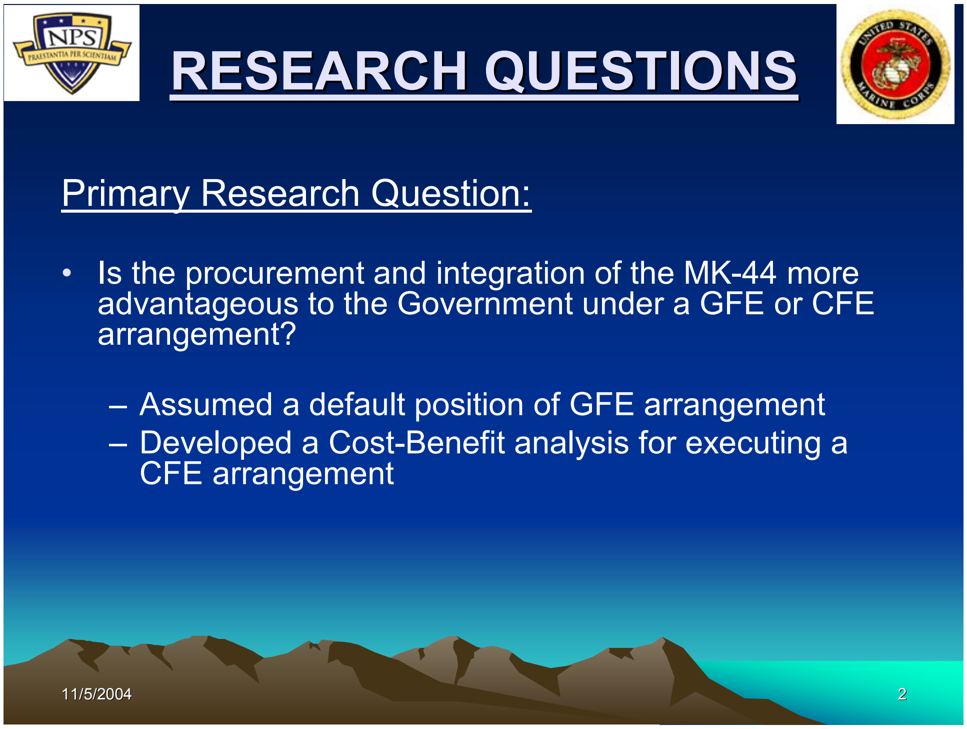
E MARI AD TERRAM
MK44



RESEARCH QUESTIONS

Primary Research Question:

- Is the procurement and integration of the MK-44 more advantageous to the Government under a GFE or CFE arrangement?
  - Assumed a default position of GFE arrangement
  - Developed a Cost-Benefit analysis for executing a CFE arrangement

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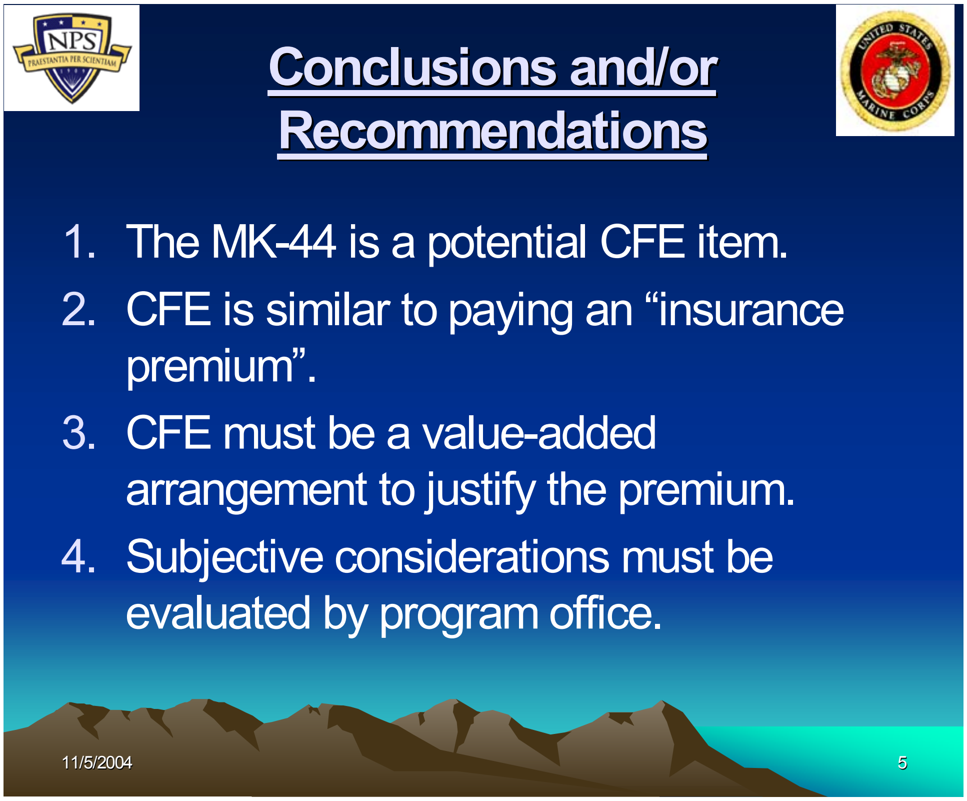

Conclusions and/or Recommendations

1. The MK-44 is a potential CFE item.
2. CFE is similar to paying an “insurance premium”.
3. CFE must be a value-added arrangement to justify the premium.
4. Subjective considerations must be evaluated by program office.

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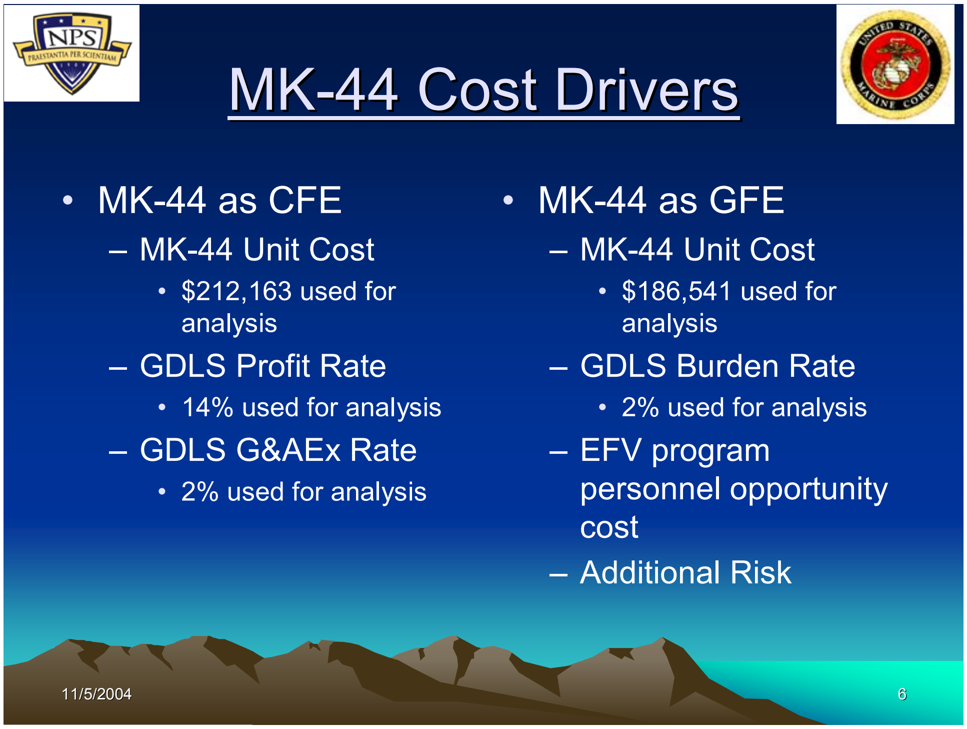

MK-44 Cost Drivers

- MK-44 as CFE
  - MK-44 Unit Cost
    - $212,163 used for analysis
  - GDLS Profit Rate
    - 14% used for analysis
  - GDLS G&AEx Rate
    - 2% used for analysis
- MK-44 as GFE
  - MK-44 Unit Cost
    - $186,541 used for analysis
  - GDLS Burden Rate
    - 2% used for analysis
  - EFV program personnel opportunity cost
  - Additional Risk

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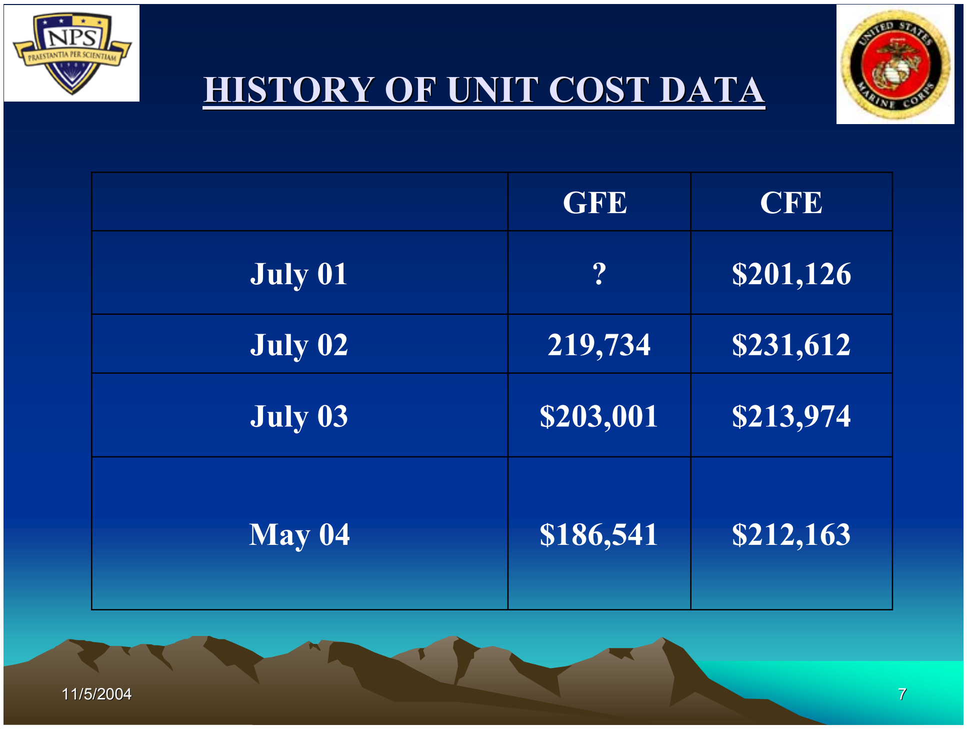

HISTORY OF UNIT COST DATA

	GFE	CFE
July 01	?	$201,126
July 02	219,734	$231,612
July 03	$203,001	$213,974
May 04	$186,541	$212,163

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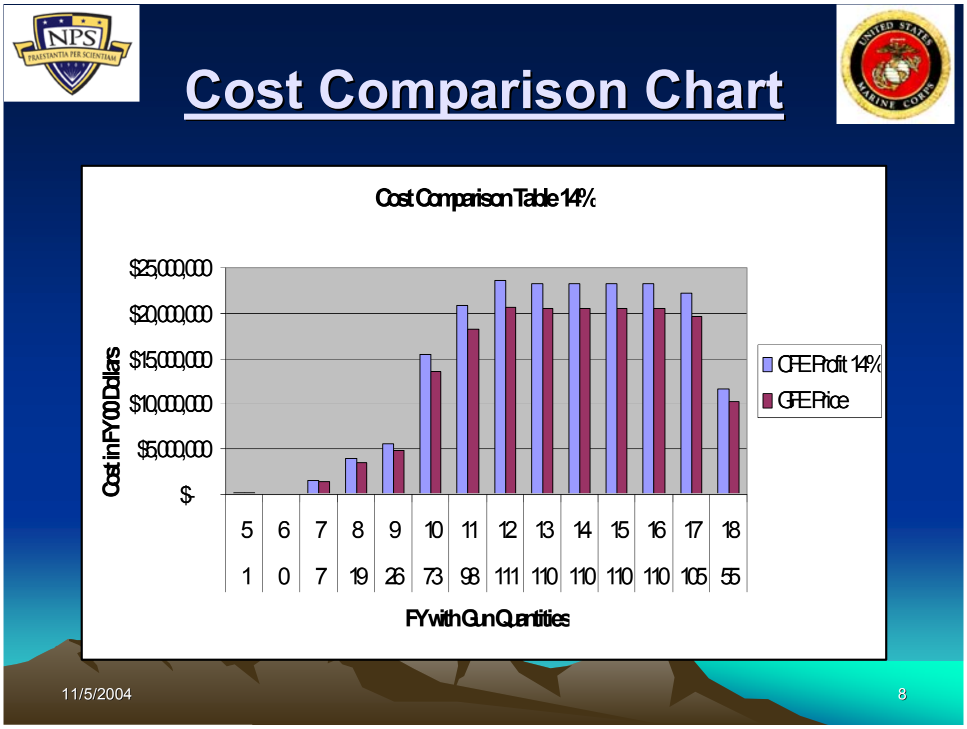

Cost Comparison Chart

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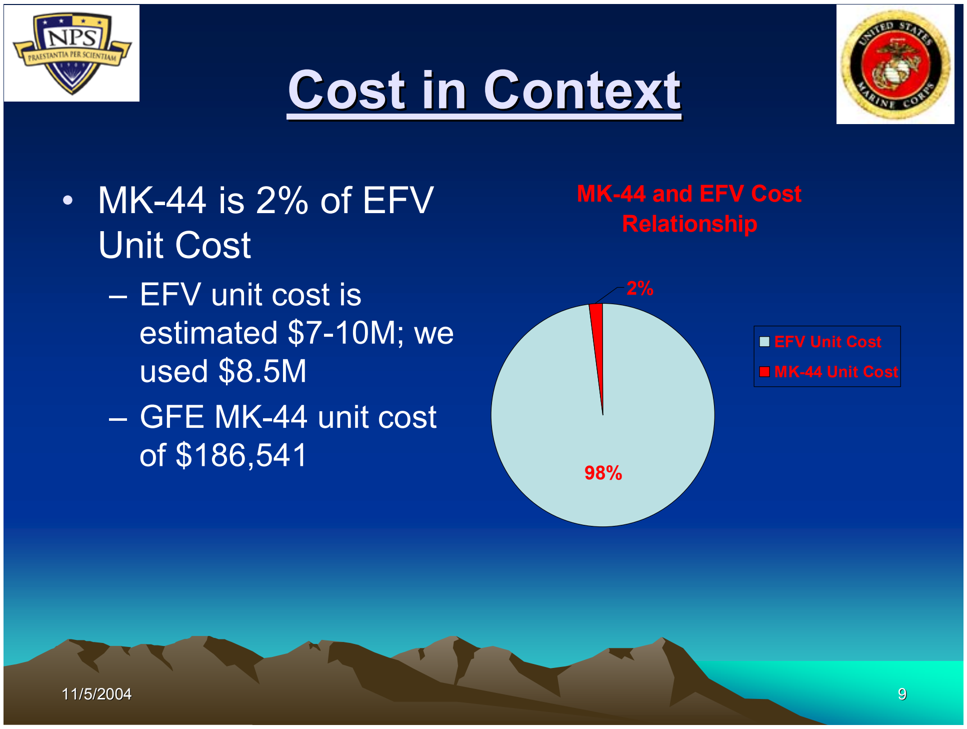
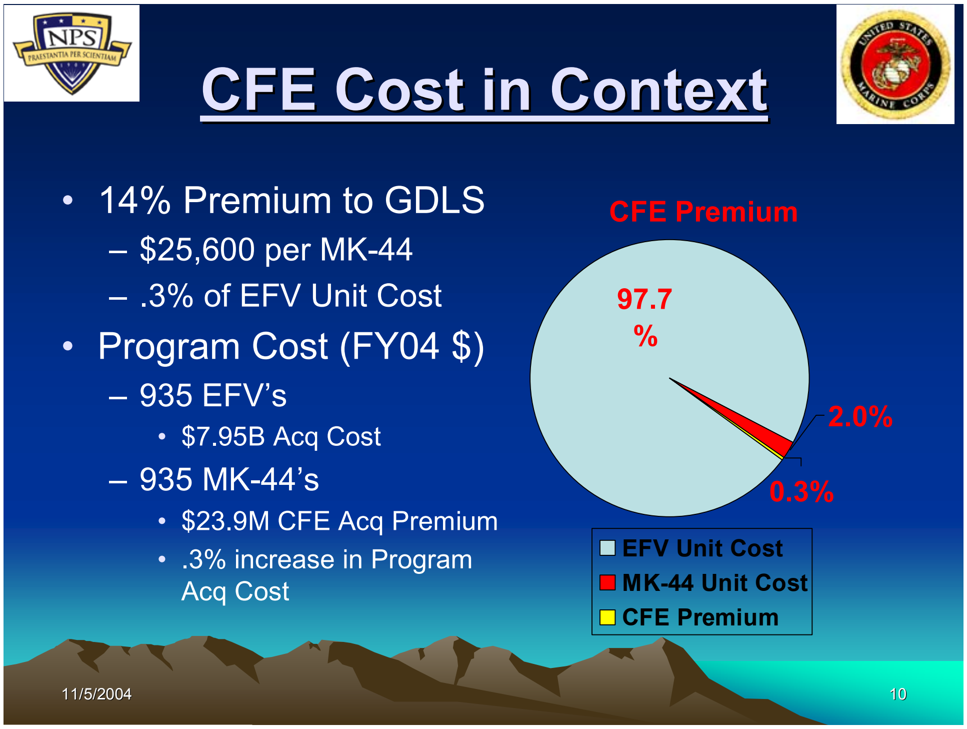


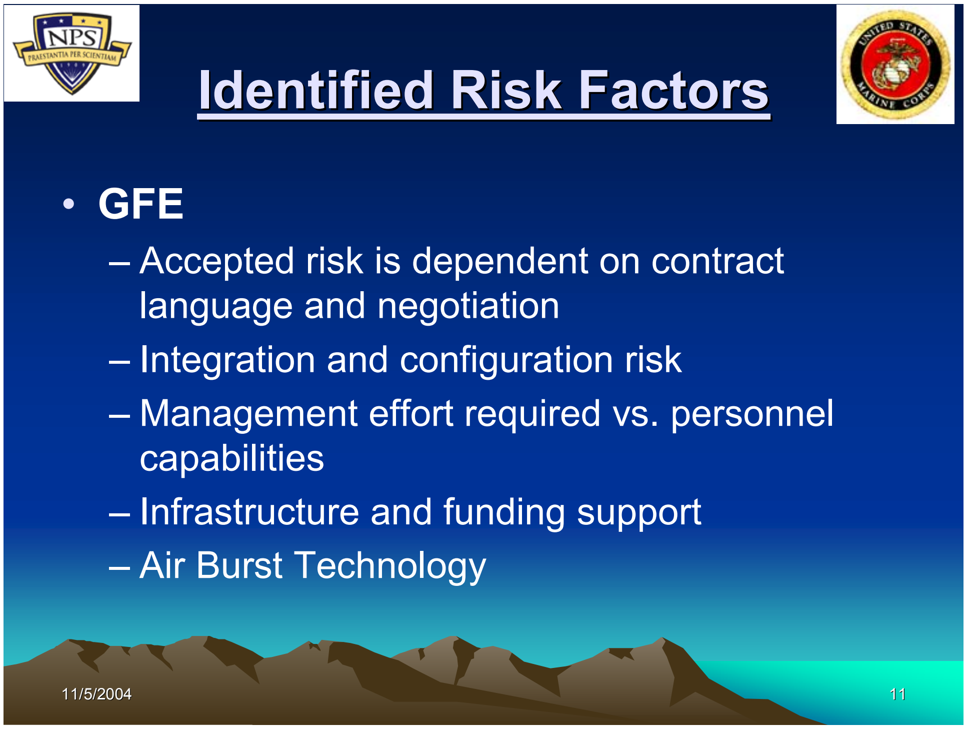
Cost in Context

- MK-44 is 2% of EFV Unit Cost
  - EFV unit cost is estimated $7-10M; we used $8.5M
  - GFE MK-44 unit cost of $186,541



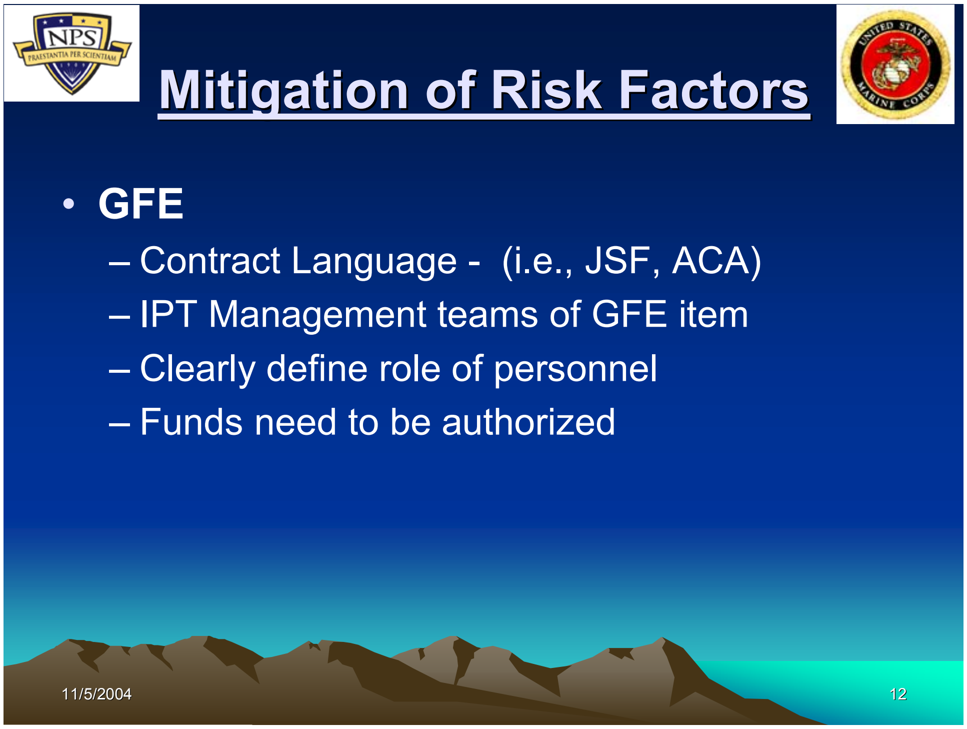
CFE Cost in Context

- 14% Premium to GDLS
  - $25,600 per MK-44
  - .3% of EFV Unit Cost
- Program Cost (FY04 $)
  - 935 EFV's
    - $7.95B Acq Cost
  - 935 MK-44's
    - $23.9M CFE Acq Premium
    - .3% increase in Program Acq Cost



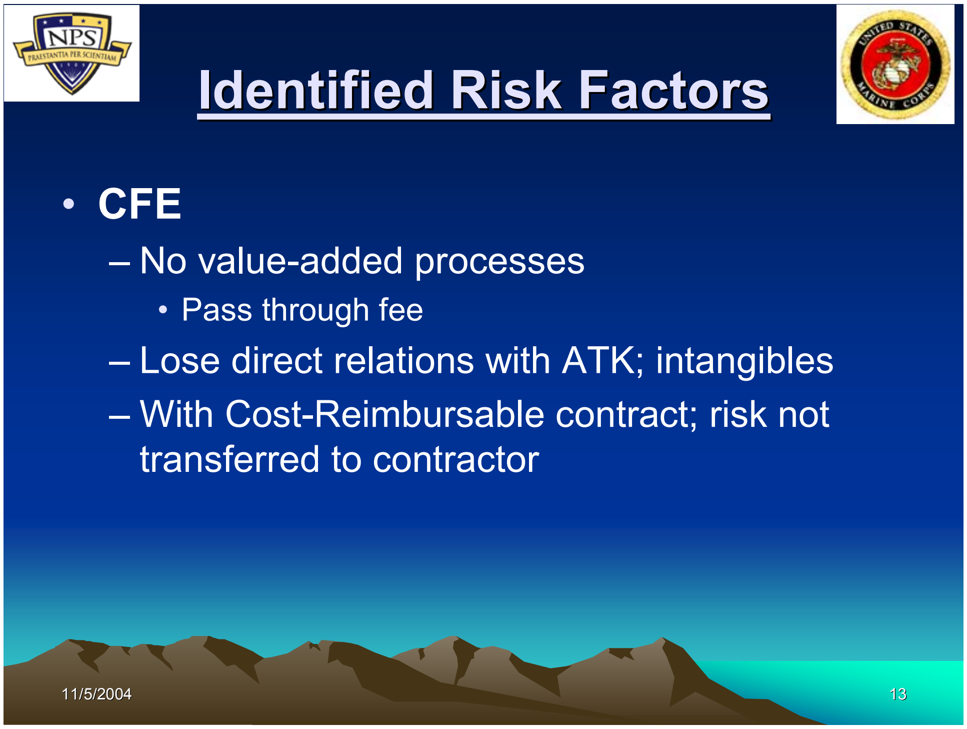
Identified Risk Factors

- GFE
  - Accepted risk is dependent on contract language and negotiation
  - Integration and configuration risk
  - Management effort required vs. personnel capabilities
  - Infrastructure and funding support
  - Air Burst Technology



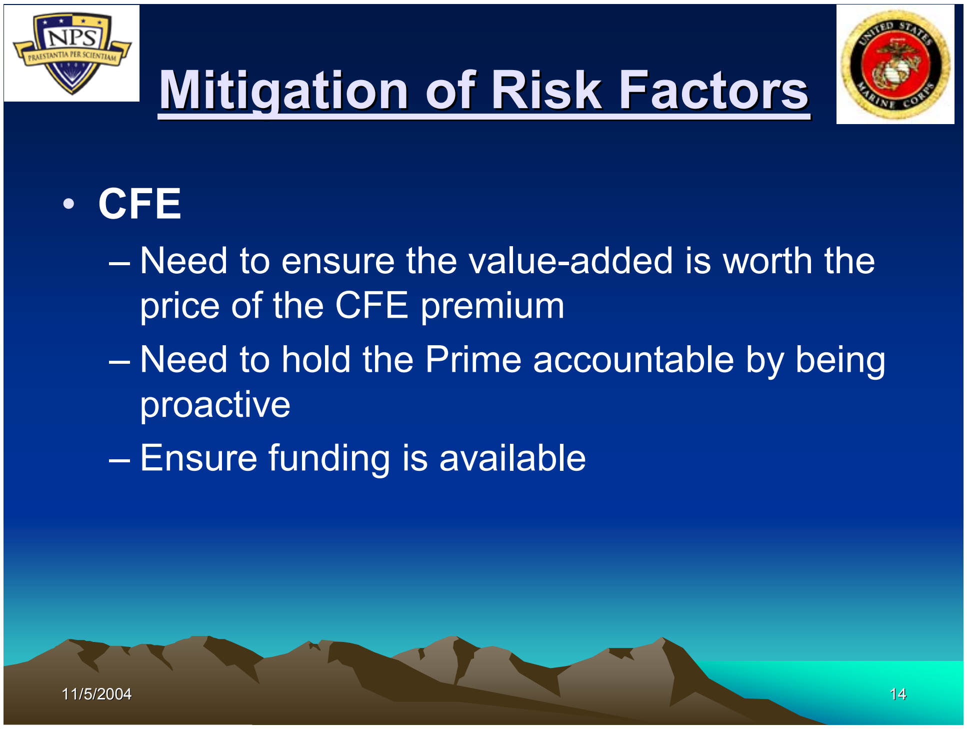
Mitigation of Risk Factors

- GFE
  - Contract Language - (i.e., JSF, ACA)
  - IPT Management teams of GFE item
  - Clearly define role of personnel
  - Funds need to be authorized



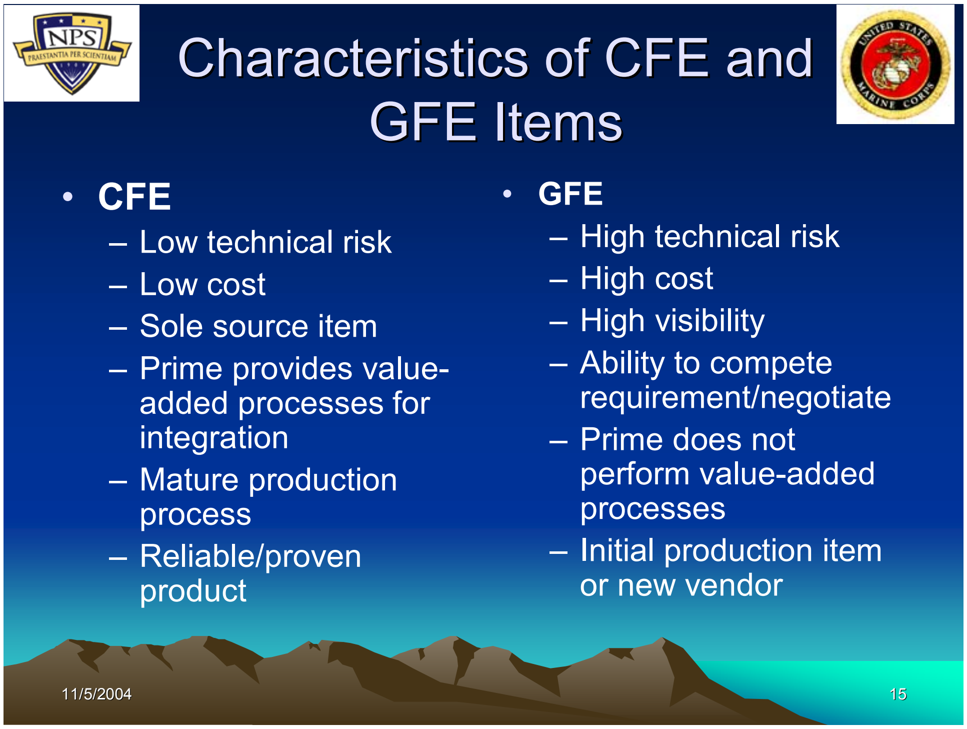
Identified Risk Factors

- CFE
  - No value-added processes
    - Pass through fee
  - Lose direct relations with ATK; intangibles
  - With Cost-Reimbursable contract; risk not transferred to contractor



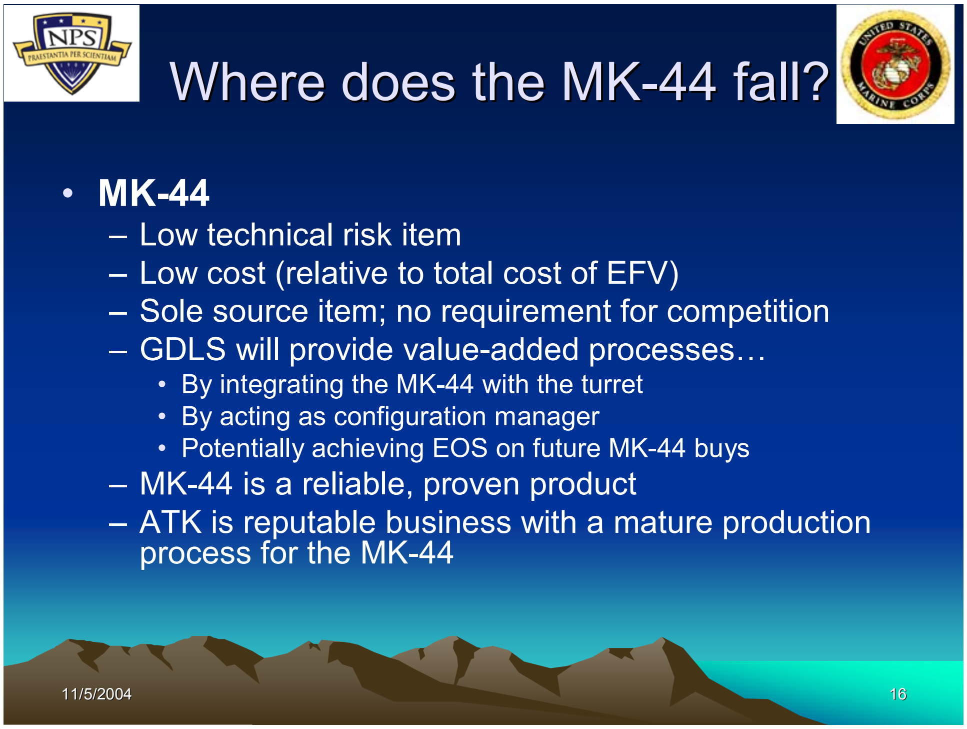
Mitigation of Risk Factors

- CFE
  - Need to ensure the value-added is worth the price of the CFE premium
  - Need to hold the Prime accountable by being proactive
  - Ensure funding is available



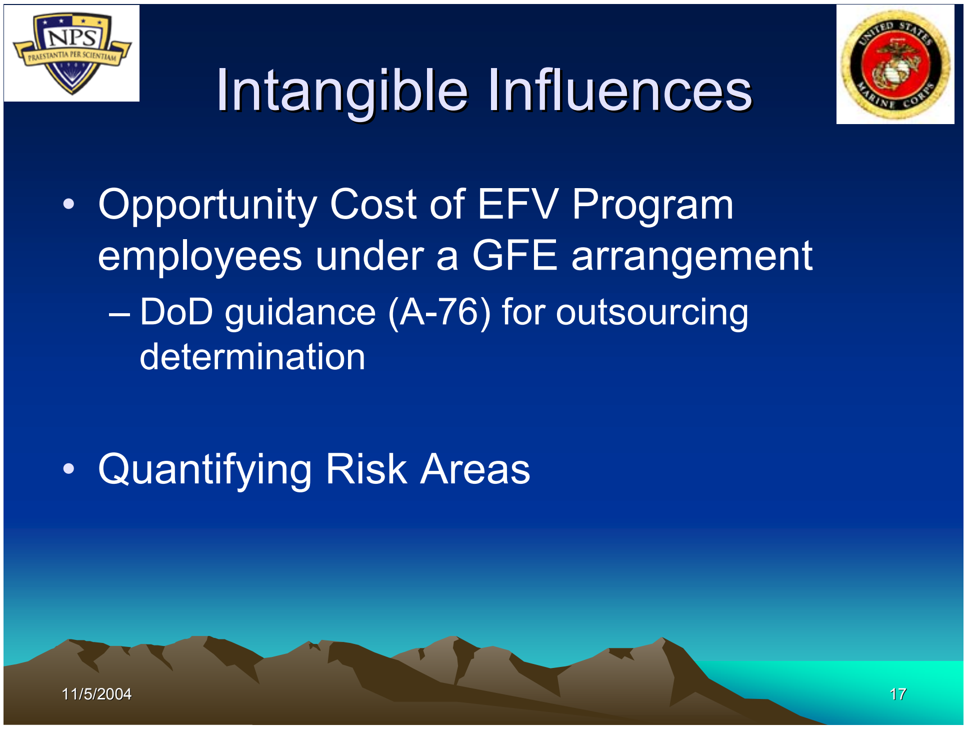
Characteristics of CFE and GFE Items

- **CFE**
  - Low technical risk
  - Low cost
  - Sole source item
  - Prime provides value-added processes for integration
  - Mature production process
  - Reliable/proven product
- **GFE**
  - High technical risk
  - High cost
  - High visibility
  - Ability to compete requirement/negotiate
  - Prime does not perform value-added processes
  - Initial production item or new vendor



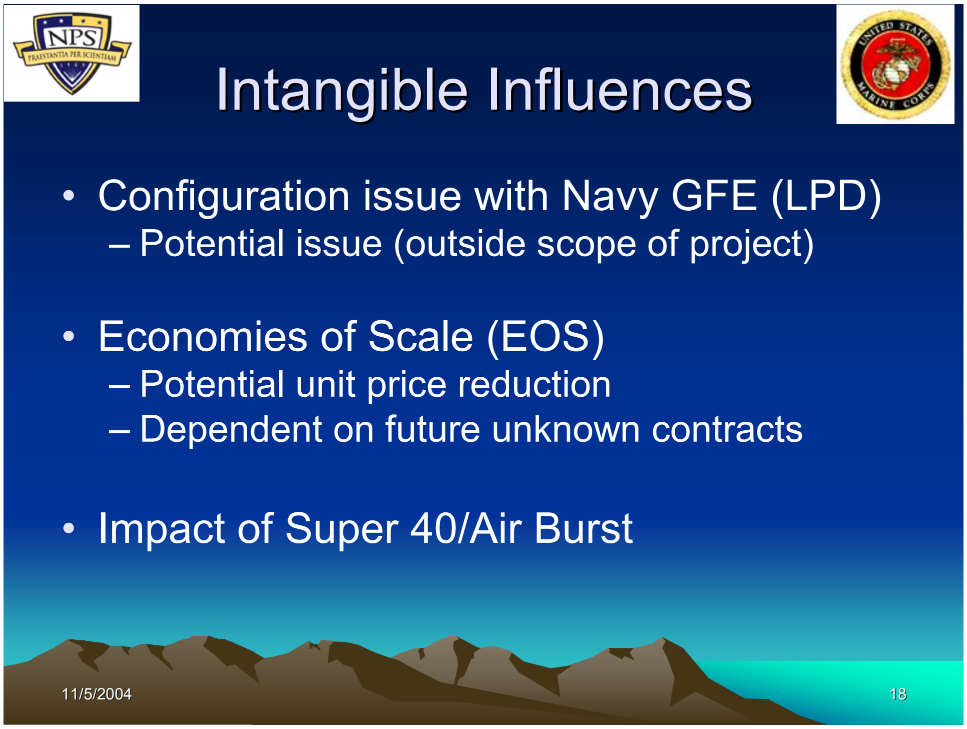
Where does the MK-44 fall?

- **MK-44**
  - Low technical risk item
  - Low cost (relative to total cost of EFV)
  - Sole source item; no requirement for competition
  - GDLS will provide value-added processes…
    - By integrating the MK-44 with the turret
    - By acting as configuration manager
    - Potentially achieving EOS on future MK-44 buys
  - MK-44 is a reliable, proven product
  - ATK is reputable business with a mature production process for the MK-44



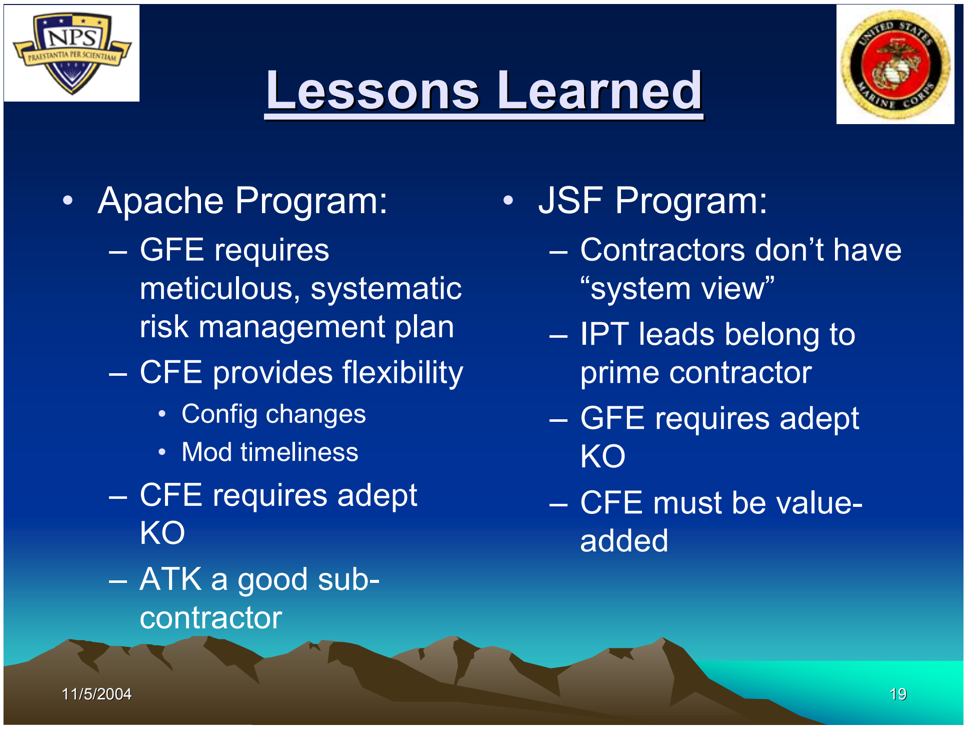
Intangible Influences

- Opportunity Cost of EFV Program employees under a GFE arrangement
  - DoD guidance (A-76) for outsourcing determination
- Quantifying Risk Areas



Intangible Influences

- Configuration issue with Navy GFE (LPD)
  - Potential issue (outside scope of project)
- Economies of Scale (EOS)
  - Potential unit price reduction
  - Dependent on future unknown contracts
- Impact of Super 40/Air Burst



Lessons Learned

- Apache Program:
  - GFE requires meticulous, systematic risk management plan
  - CFE provides flexibility
    - Config changes
    - Mod timeliness
  - CFE requires adept KO
  - ATK a good sub-contractor
- JSF Program:
  - Contractors don't have "system view"
  - IPT leads belong to prime contractor
  - GFE requires adept KO
  - CFE must be value-added

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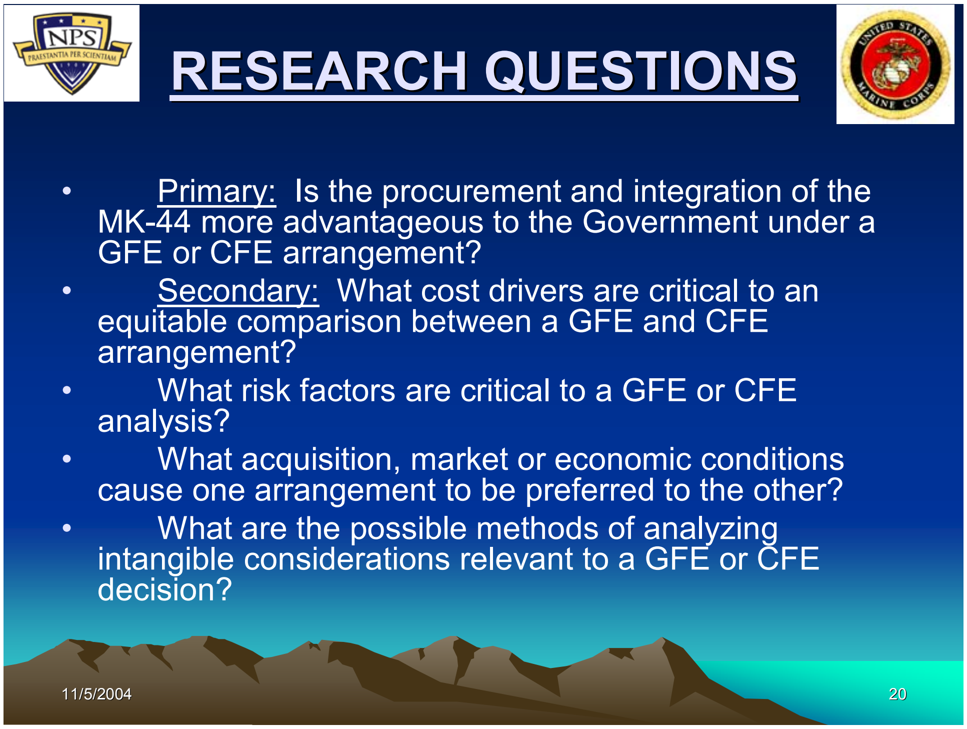

RESEARCH QUESTIONS

- Primary: Is the procurement and integration of the MK-44 more advantageous to the Government under a GFE or CFE arrangement?
- Secondary: What cost drivers are critical to an equitable comparison between a GFE and CFE arrangement?
- What risk factors are critical to a GFE or CFE analysis?
- What acquisition, market or economic conditions cause one arrangement to be preferred to the other?
- What are the possible methods of analyzing intangible considerations relevant to a GFE or CFE decision?

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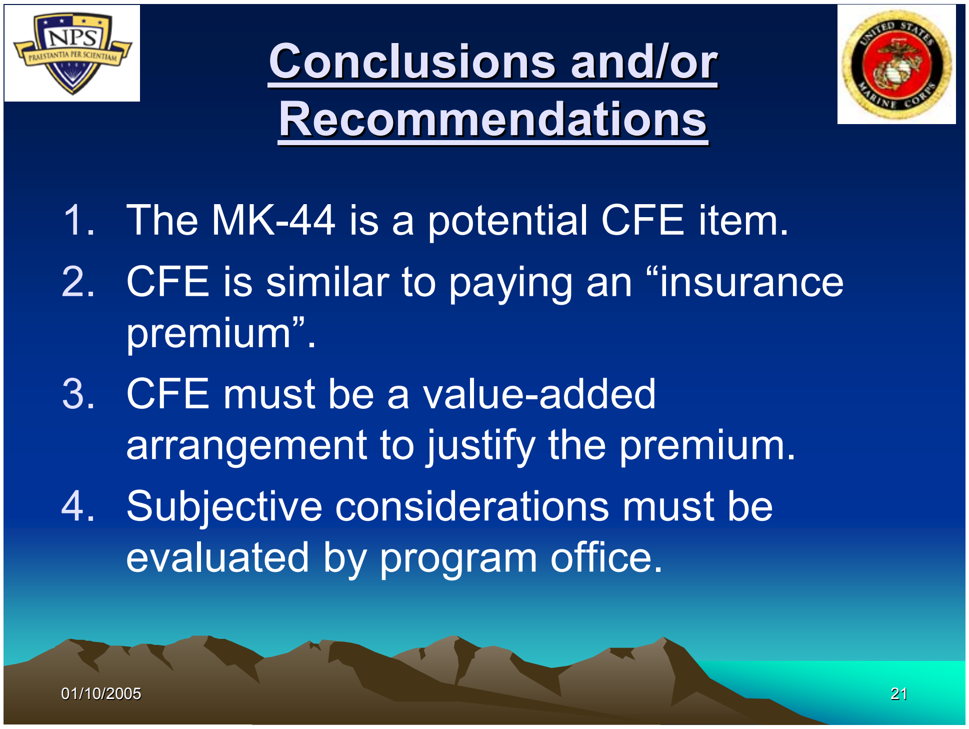

Conclusions and/or Recommendations

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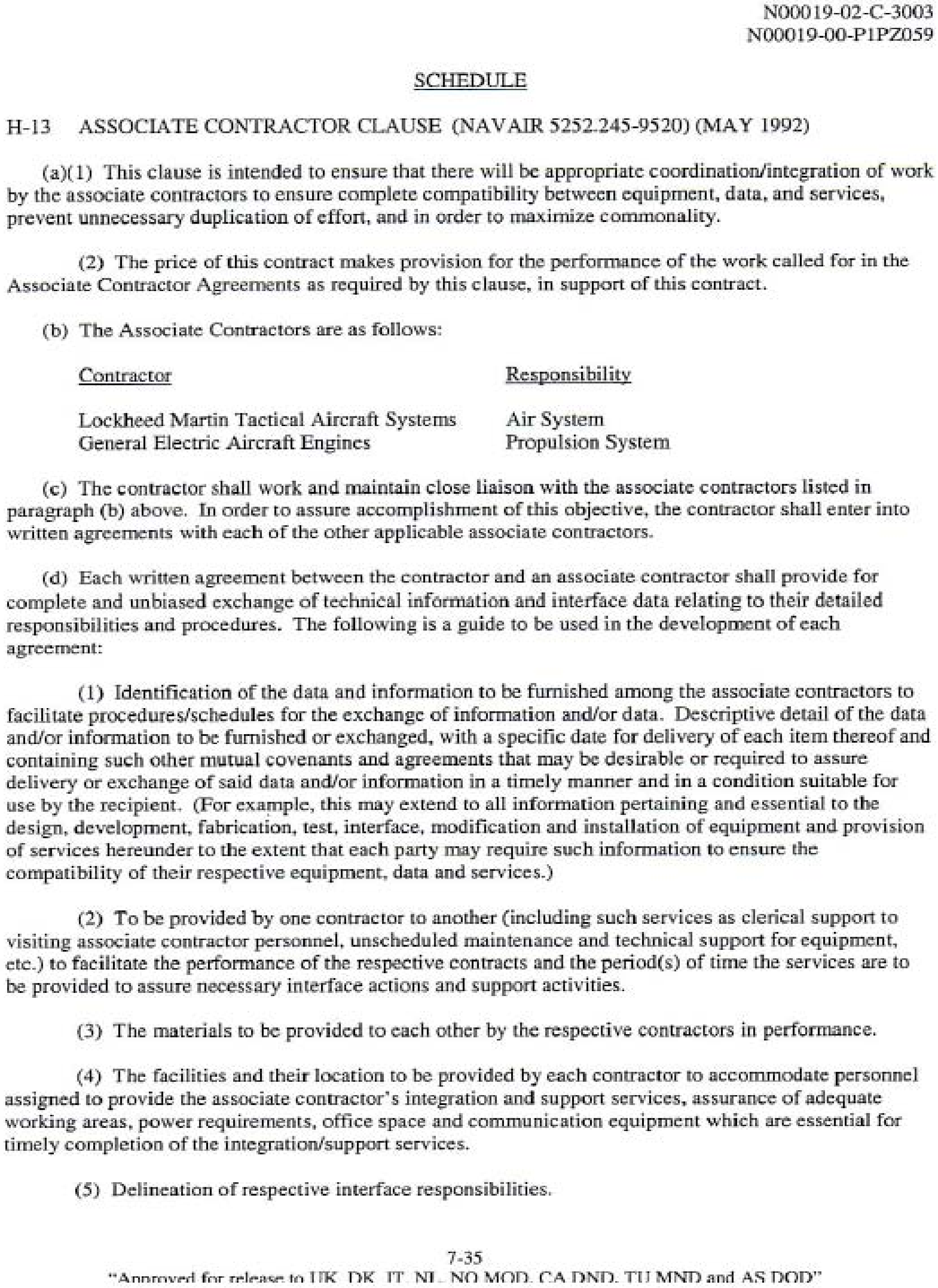
APPENDIX D: ASSOCIATE CONTRACTOR CLAUSE JSF PROGRAM



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SCHEDULE

H-13 ASSOCIATE CONTRACTOR CLAUSE (NAVAIR 5252.245-9520) (MAY 1992)

(a)(1) This clause is intended to ensure that there will be appropriate coordination/integration of work by the associate contractors to ensure complete compatibility between equipment, data, and services, prevent unnecessary duplication of effort, and in order to maximize commonality.

(2) The price of this contract makes provision for the performance of the work called for in the Associate Contractor Agreements as required by this clause, in support of this contract.

(b) The Associate Contractors are as follows:

Contractor	Responsibility
Lockheed Martin Tactical Aircraft Systems	Air System
General Electric Aircraft Engines	Propulsion System

(c) The contractor shall work and maintain close liaison with the associate contractors listed in paragraph (b) above. In order to assure accomplishment of this objective, the contractor shall enter into written agreements with each of the other applicable associate contractors.

(d) Each written agreement between the contractor and an associate contractor shall provide for complete and unbiased exchange of technical information and interface data relating to their detailed responsibilities and procedures. The following is a guide to be used in the development of each agreement:

(1) Identification of the data and information to be furnished among the associate contractors to facilitate procedures/schedules for the exchange of information and/or data. Descriptive detail of the data and/or information to be furnished or exchanged, with a specific date for delivery of each item thereof and containing such other mutual covenants and agreements that may be desirable or required to assure delivery or exchange of said data and/or information in a timely manner and in a condition suitable for use by the recipient. (For example, this may extend to all information pertaining and essential to the design, development, fabrication, test, interface, modification and installation of equipment and provision of services hereunder to the extent that each party may require such information to ensure the compatibility of their respective equipment, data and services.)

(2) To be provided by one contractor to another (including such services as clerical support to visiting associate contractor personnel, unscheduled maintenance and technical support for equipment, etc.) to facilitate the performance of the respective contracts and the period(s) of time the services are to be provided to assure necessary interface actions and support activities.

(3) The materials to be provided to each other by the respective contractors in performance.

(4) The facilities and their location to be provided by each contractor to accommodate personnel assigned to provide the associate contractor's integration and support services, assurance of adequate working areas, power requirements, office space and communication equipment which are essential for timely completion of the integration/support services.

(5) Delineation of respective interface responsibilities.

7-35

"Approved for release to UK, DK, IT, NL, NO MOD, CA DND, TU MND and AS DOD"

SCHEDULE

(6) Provision for furnishing copies of communications relative to performance of associate contractor responsibilities.

(e) In the event this exchange of information/data results in access to limited rights data the contractor hereby agrees not to utilize such limited rights data acquired under the exchange or to manufacture itself those items identified above, or components thereof.

(f) In the event limited rights data is obtained from the contractors designated herein, the contractor agrees to obtain in writing from each of his employees whose responsibility in connection with work under this contract involves access to this data, an agreement which in substance provides a statement that said employee(s) will not, during his employment by the contractor or thereafter, disclose to employees of the company submitting unlimited rights information, employees other than the contractor's employees for use for his own benefit or the future benefit of any other individual, corporation or any organization, any limited rights information/data to which he had access in connection with this contract. Nothing contained in this provision applies to data furnished voluntarily by individuals, corporations or organizations without limitations as to use or to data that falls within public domain.

(g) Each Associate Contractor Agreement shall be submitted to the Government for review prior to execution. Following Government concurrence and execution by both associate contractors, each Associate Contractor Agreement may be made an attachment to this contract. The Associate Contractor Agreements are for information purposes only and shall not be subject to or governed by this contract. In the event of a conflict between the terms of this contract and terms of the aforesaid agreement, the terms of this contract shall control.

(h) Where the contractor and an associate contractor fail to agree upon action to be taken in connection with their respective responsibilities, each contractor shall promptly bring the matters to the attention of the cognizant PCO and furnish the contractor's recommendations for a solution. The contractor shall not be relieved of its obligations to make timely deliveries or be entitled to any other adjustment because of failure of the contractor and its associate to promptly refer matters to the PCO or because of failure to implement PCO directions.

H-14 RESERVED

APPENDIX E: JSP IPT MANAGEMENT CLAUSE

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SCHEDULE

H-2 PROPULSION SYSTEM MANAGEMENT

This clause is included in the Joint Strike Fighter (JSF) Air System Contractor's (ASC's) ar Pratt and Whitney's (P&W's) Systems Development and Demonstration (SDD) contracts, and General Electric Aircraft Engine's (GEAE's) F136 Pre-SDD contract. P&W and GEAE are Propulsion System Contractors (PSCs). This clause is included to promote a common understanding of the roles and responsibilities of all parties of the JSF Propulsion Integrated Product Team (IPT) and the IPT-Managed JSF Propulsion System processes that shall be used during the JSF Air System SDD Program.

(a) Requirements.

The P&W F135 and the GEAE F136 propulsion systems shall be: interchangeable without Air Vehicle modification; functionally equivalent; and integrated and compatible with the JSF Air System (which includes the Air Vehicle and its Autonomous Logistics System). The F135 and F136 propulsion systems shall be interchangeable within the JSF Air System throughout the life of the JSF Air System. The propulsion system is comprised of an engine and common propulsion components (hardware and software). The engine is defined as the inlet case to the turbine frame, and it shall be compatible with th common propulsion components throughout the life of the JSF Air System. Common propulsion components are defined as those parts of the propulsion system that operate as a part of either PSC's propulsion system.

(b) Propulsion IPT Management Roles and Responsibilities.

(1) The ASC shall have Total System Performance and Integration Responsibility (TSPIR), as defined in Special Contract Provision H-15, "Performance Responsibility." The ASC shall lead the JSF Propulsion IPT and all efforts required in the management of the optimization and integration of the interchangeable propulsion systems with the Air System. The ASC shall also lead the efforts required in the management of the optimization of the common propulsion components. The ASC shall ensure execution of the three-party Associate Contractor Agreement (ACA) described in paragraph (c) below; the Propulsion System Management Plan in (d) below; the weight management philosophy in (e) below; and the In-Flight Thrust (IFT) methodologies in (f) below. The ASC shall also be responsible for providing a coordinated copy of the ACA to the Government for review and comment prior to ASC Contract award.

(2) P&W has Propulsion System Performance and Integration Responsibility (PSPIR), as define in Special Contract Provision H-15, "Performance Responsibility" for the F135 Propulsion System. P&W shall work with the ASC to optimize and integrate the F135 Propulsion System into the Air Systen P&W shall work with GEAE in defining, optimizing and integrating common components with the F135 and the F136 to ensure interchangeable propulsion systems. P&W shall develop, qualify, and deliver the common propulsion components. P&W shall work with the ASC and GEAE to prepare and execute the three-party ACA described in paragraph (c) below. P&W shall be a member of the JSF Propulsion IPT.

(3) GEAE, under its prime Pre-SDD contract and SDD* contract, has PSPIR, as defined in Special Contract Provision H-27, "Performance Responsibility" for the F136 Propulsion System. GEAE shall work with the ASC to optimize and integrate the F136 Propulsion System into the Air System. GEAE shall work with P&W in defining, optimizing and integrating common components with the F135 and the F136 to ensure interchangeable propulsion systems. GEAE shall work with the ASC and P&W tc prepare and execute the three-party ACA described in paragraph (c) below. GEAE shall be a member of the JSF Propulsion IPT.

(4) The Government will procure and deliver to the ASC the propulsion systems identified in tl JSF Air System SDD Contract Government Furnished Property Clause. The Government will procure a deliver to GEAE the common propulsion system components identified in the GEAE F136 Pre-SDD an SDD* contracts Government Furnished Property Clauses. The Government will ensure that any conflic in requirements of the JSF SDD Air System and JSF Propulsion System contracts are resolved expeditiously. The Government will have final decision authority for all propulsion system developmer issues. The Government will participate on the JSF Propulsion IPT to obtain the necessary insight into the management of the optimization and integration of the propulsion systems.

(5) In order to meet contractual performance requirements of the JSF Propulsion System Contracts and the Air System Contract, the PSCs and ASC are each authorized to use and/or incorporate into the propulsion system and/or air system, material identified by category below and as further define in Attachment (B) Propulsion System Material List, of the three party Associate Contractor Agreement: 1) material to support ASC testing (ground and flight), PSC testing and system integration testing; 2) material to support design, analysis and simulation activities; 3) material to support hardware or other deliveries (engines, engine systems, aircraft, CDRLs, etc.); 4) integration and installation data, models, simulations and hardware; 5) autonomic logistics material; 6) material to support environmental, safety and health (ESH) activities; and 7) material to support survivability design, testing and analysis. The PSCs and ASC, in concert with on-site Defense Contract Management Agency (DCMA) Offices, shall establish material transfer processes that allow maximum flexibility for use/incorporation of the material identified in the ACA Attachment (B) Propulsion System Material List. These processes must be in accordance with existing company material processing policies and procedures.

Material delivery arrangements shall be made pursuant to paragraphs c(3) and c(9) herein. If material is not received as arranged, the ASC and PSCs shall mitigate impacts to the JSF program, to the maximum extent practicable. The Contractor receiving the material shall submit timely notifications of deficiencies, documenting actions taken to mitigate any impacts to the Propulsion System or Air System program(s). Repair or replacement of defective or deficient material is not the responsibility of the contractor receiving the material, resolution will be determined through the IPT managed processes set forth in the Propulsion System Management Plan. Any and all equitable adjustments to this contract sha be processed pursuant to the procedures of the "Changes" clause of this contract. The right to an equitable adjustment is the exclusive remedy under this special provision.

(c) Associate Contractor Agreement.

The propulsion system development and integration responsibilities of the ASC, P&W and GEA shall be set forth in a three-party Associate Contractor Agreement (ACA). In addition to complying with all requirements in Special Contract Provision H-13, "Associate Contractor Agreement," the ACA shall embody the following requirements:

(1) Incorporate the ASC's JSF Propulsion System Management Plan, per paragraph (d) below, which details the Propulsion System development and integration responsibilities as well as management processes of the ASC, P&W, and GEAE.

(2) Incorporate by reference the JSF Propulsion System Contract Specifications and JSF Propulsion System Common Hardware Interface Control Document for the P&W and GEAE propulsion systems as agreed to between the parties, and set forth as a Contract Attachment in each propulsion system contract.

(3) Incorporate the "Material" list covering ASC/PSC and PSC/PSC requirements discussed in paragraph (b)(5) above.

(4) Provide for direct liaison, and electronic interchange and delivery of schedule data to all parties as required.

(5) Provide for the preparation and electronic delivery of propulsion system data to the ASC for use in the Air System Lifecycle Plan.

(6) Provide for the preparation of specific engine operation instructions to be submitted to the ASC and the Government.

(7) Provide for the review of Air System Technical Orders and Flight Manuals to evaluate the effects on aircraft and engine installation and operation.

(8) Provide for the evaluation and review by the appropriate parties of the effect on engine installation or operation of any proposed change in the air system or either propulsion system.

(9) Provide for the preparation of field surveys for each proposed propulsion system specificatio change that affects air system engine installation or operation. Each survey submitted to the Government shall include the PSCs' request for approval and copies of the ASC's comments to proposed changes.

(10) Provide for electronic communication between the PSCs and the ASC to address questions and answers through the use of "Coordination Memos," with copies provided to the Air System and Propulsion System CORs via the JSF Virtual Enterprise.

(11) In the event of conflict between the ACA and the contract, the contract shall take precedence.

(d) Propulsion System Management Plan

The ASC, as lead for the IPT-Managed JSF Propulsion System, shall coordinate agreement of an document the management roles and responsibilities of all four parties, identified in paragraph (b) above, necessary to allow successful integration of the propulsion system into the air system including the implementation and update of the Interface Control Documents (ICDs) between the ASC and each PSC and between the two PSCs.

The ASC shall also provide an outline of management processes for assessing and resolving interface problems using optimization of the air system, support system, and total government ownership cost as the primary trade criteria. Other ASC defined processes shall include, but not be limited to: issue resolution; weight management; configuration and interface control between the air system, the propulsion system, and the common propulsion components; ACA Material List update/changes; ICD updates; communication and coordination; and PSC contract specification changes.

The ASC shall manage the above processes through establishment of a Program Leadership Tean (PLT), Propulsion Control Boards (PCBs), Propulsion System Integration Boards (PSIBs) and a Propulsion Associate Contractor Working Group (ACWG) as described below:

(1) JSF Propulsion Leadership Team. A JSF PLT shall be established to provide overall JSF propulsion program guidance and resolve major programmatic issues not resolved at the PCB or

SCHEDULE

ACWG. Membership on the PLT will include the ASC Propulsion IPT Leader (Chair), Government Propulsion IPT Leader, P&W JSF Program Director, and GEAE JSF Program Director as voting members.

(2) Propulsion Control Board. Separate F135 and F136 PCBs shall be established to manage the integration of each propulsion system with the air system, and to ensure that the P&W SDD Program and the GEAE Pre-SDD and SDD* Programs support the ASC SDD Program. Each PCB shall also monitor the progress of its Propulsion system contract and resolve issues not resolved by its PSIB or its PSC IPT. The PCB membership will include representatives from the ASC (Chairman), the Government, and P&W for the F135 PCB or GEAE for the F136 PCB.

(3) Propulsion System Integration Board. Separate F135 and F136 PSIBs shall be established to resolve interface issues between the Air System and each Propulsion System. The PSIB will also ensure the exchange of data and information among the parties necessary to optimize propulsion system installation. The PSIB membership will include representatives from the ASC (Chairman), the Government, and P&W for the F135 PSIB or GEAE for the F136 PSIB.

(4) Propulsion Associate Contractor Working Group. A JSF Propulsion ACWG shall be established to facilitate the interchangeability of the F135 and F136 engines with the common propulsion components. The focus of the ACWG will be to resolve issues involving the integration of the common propulsion components with the F135 and F136 Propulsion Systems in order to achieve engine interchangeability. The ACWG will also ensure the exchange of data and information among the parties necessary to achieve engine interchangeability. The JSF Propulsion ACWG membership will include representatives from the ASC (Chairman), the Government, P&W and GEAE.

(e) Weight.

Solely for weight-related issues, all parties understand and agree that: 1) P&W will have met its obligation under its JSF Propulsion System SDD contract and the Government will have met its obligation under the JSF ASC SDD contract if flight test propulsion systems are delivered to the ASC with a weight less than or equal to the Not To Exceed Weights (CTOL [redacted] lbs, CV [redacted] lbs, STOVL [redacted] lbs); 2) the Government will not seek an equitable adjustment from P&W if the flight test propulsion systems are delivered to the ASC with a weight less than or equal to the Not To Exceed Weights; 3) the ASC shall not be entitled to an equitable adjustment to the cost, schedule, JSF Air System Contract Specification, award fee criteria or other requirements of the Air System contract if the flight test propulsion systems are delivered to the ASC with a weight less than or equal to the Not To Exceed Weights; and 4) the ASC may be entitled to an equitable adjustment if the flight test propulsion systems are delivered to the ASC with a weight greater than the Not To Exceed Weight.

(f) In-Flight (IFT) Methodologies

The ASC, in conjunction with each PSC, shall develop two independent methodologies for determining In-Flight Thrust for use during flight test to evaluate performance guarantees for all variants and flight regimes.

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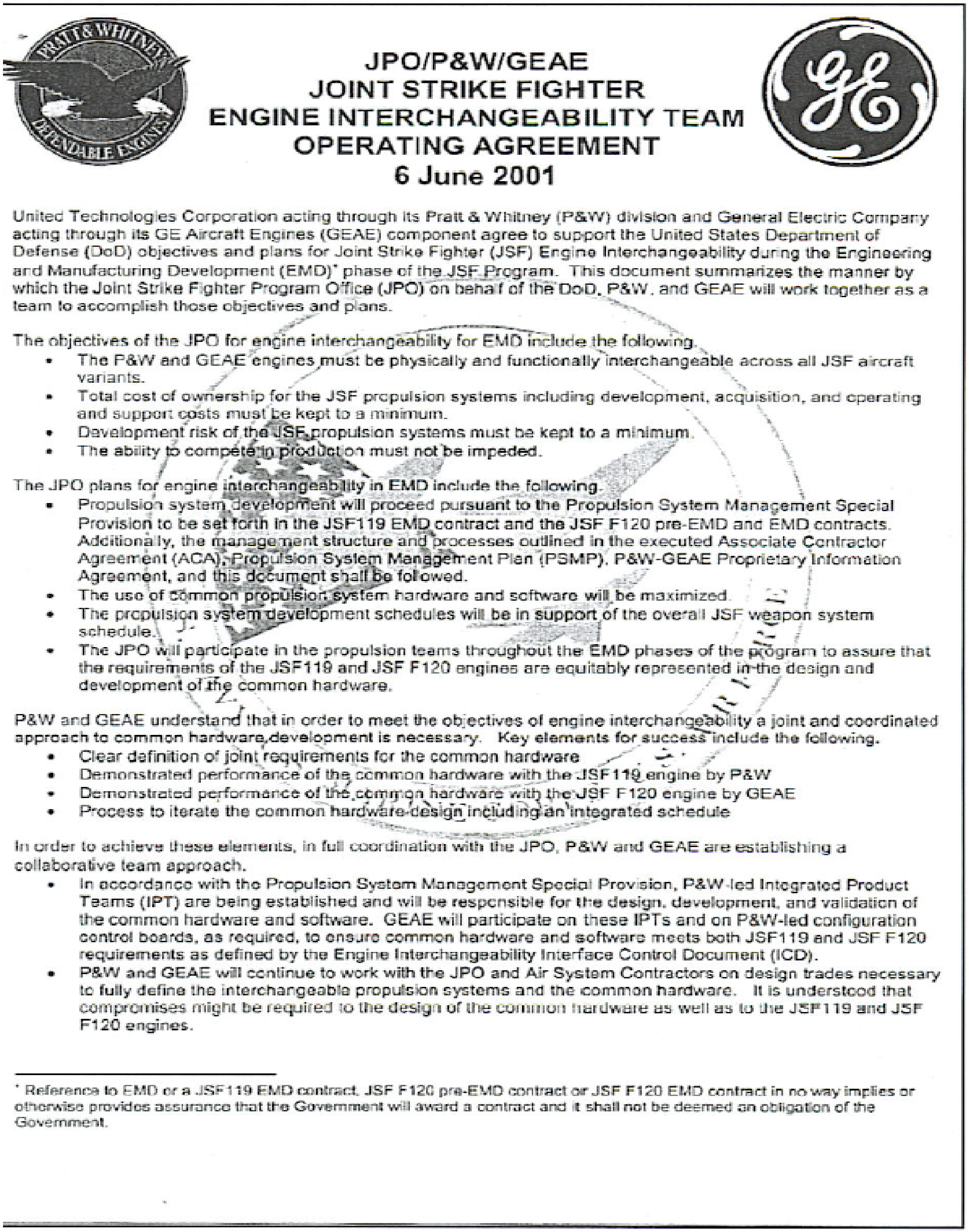
* Reference to an F136 SDD contract in no way implies or otherwise provides assurance that the Government will award an F136 SDD contract to GEAE and shall not be deemed an obligation of the Government.

APPENDIX F: JSF ENGINE INTERCHANGEABILITY AGREEMENT



JPO/P&W/GEAE JOINT STRIKE FIGHTER ENGINE INTERCHANGEABILITY TEAM OPERATING AGREEMENT

6 June 2001

United Technologies Corporation acting through its Pratt & Whitney (P&W) division and General Electric Company acting through its GE Aircraft Engines (GEAE) component agree to support the United States Department of Defense (DoD) objectives and plans for Joint Strike Fighter (JSF) Engine Interchangeability during the Engineering and Manufacturing Development (EMD)* phase of the JSF Program. This document summarizes the manner by which the Joint Strike Fighter Program Office (JPO) on behalf of the DoD, P&W, and GEAE will work together as a team to accomplish those objectives and plans.

The objectives of the JPO for engine interchangeability for EMD include the following.

- The P&W and GEAE engines must be physically and functionally interchangeable across all JSF aircraft variants.
- Total cost of ownership for the JSF propulsion systems including development, acquisition, and operating and support costs must be kept to a minimum.
- Development risk of the JSF propulsion systems must be kept to a minimum.
- The ability to compete in production must not be impeded.

The JPO plans for engine interchangeability in EMD include the following.

- Propulsion system development will proceed pursuant to the Propulsion System Management Special Provision to be set forth in the JSF119 EMD contract and the JSF F120 pre-EMD and EMD contracts. Additionally, the management structure and processes outlined in the executed Associate Contractor Agreement (ACA), Propulsion System Management Plan (PSMP), P&W-GEAE Proprietary Information Agreement, and this document shall be followed.
- The use of common propulsion system hardware and software will be maximized.
- The propulsion system development schedules will be in support of the overall JSF weapon system schedule.
- The JPO will participate in the propulsion teams throughout the EMD phases of the program to assure that the requirements of the JSF119 and JSF F120 engines are equitably represented in the design and development of the common hardware.

P&W and GEAE understand that in order to meet the objectives of engine interchangeability a joint and coordinated approach to common hardware development is necessary. Key elements for success include the following.

- Clear definition of joint requirements for the common hardware
- Demonstrated performance of the common hardware with the JSF119 engine by P&W
- Demonstrated performance of the common hardware with the JSF F120 engine by GEAE
- Process to iterate the common hardware design including an integrated schedule

In order to achieve these elements, in full coordination with the JPO, P&W and GEAE are establishing a collaborative team approach.

- In accordance with the Propulsion System Management Special Provision, P&W-led Integrated Product Teams (IPT) are being established and will be responsible for the design, development, and validation of the common hardware and software. GEAE will participate on these IPTs and on P&W-led configuration control boards, as required, to ensure common hardware and software meets both JSF119 and JSF F120 requirements as defined by the Engine Interchangeability Interface Control Document (ICD).
- P&W and GEAE will continue to work with the JPO and Air System Contractors on design trades necessary to fully define the interchangeable propulsion systems and the common hardware. It is understood that compromises might be required to the design of the common hardware as well as to the JSF119 and JSF F120 engines.

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* Reference to EMD or a JSF119 EMD contract, JSF F120 pre-EMD contract or JSF F120 EMD contract in no way implies or otherwise provides assurance that the Government will award a contract and it shall not be deemed an obligation of the Government.

- P&W and GEAE will work together to develop common hardware requirements and the Engine Interchangeability ICD. P&W and GEAE will work with the ASC as described in the ACA and PSMP to assure the overall propulsion system meets air system needs.
- P&W will validate through analysis and/or test that the common hardware meets the specification and ICD requirements.
- P&W will validate through analysis and/or test that the total JSF119 propulsion system, including common hardware, meets specification requirements.
- GEAE will validate through analysis and/or test that the total JSF F120 propulsion system, including the common hardware, meets specification requirements.
- Should either propulsion system including common hardware not meet specification, design trades will be made to determine the most affordable manner to meet the specification. Any resulting changes to the common hardware will be demonstrated by P&W with the JSF119 and will be demonstrated by GEAE using the JSF F120 engines.

The JPO/P&W/GEAE Engine Interchangeability Team will employ the use of joint management and technical processes to affordably achieve the objectives of engine interchangeability. Examples of these processes include the following.

- Program management processes – earned value management, risk management, program management reviews, IPT structure and operating guidelines, communications, and integrated program plans and schedules
- Common hardware requirements and specification development processes – system requirements definition, system performance allocation, common hardware interface control documents and specification
- Systems engineering processes – performance analysis, system model interfaces, configuration management, risk and weight management, control and software management, data exchange, trade study and exit criteria, joint design reviews
- Other processes – supportability and maintainability, validation and qualification, test facility utilization, tooling and manufacturing

In addition to the planned ASC-led joint leadership teams and to help assure continuing focus on JPO objectives, executive representatives of the JPO/P&W/GEAE Engine Interchangeability Team will meet with the JSF Service Acquisition Executive semi-annually, or as required, throughout EMD to review status of the program.

All members of P&W's JSF119 and GEAE's JSF F120 Propulsion System Teams are committed to working with the JPO to achieve the objectives of the Joint Strike Fighter Program. We are looking forward to a successful collaborative effort during EMD.

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This document does not obligate the Government to reimburse P&W and GEAE for any costs incurred that are not reimbursable under a contract and does not establish any substantive or procedural rights of the parties. Obligations will only be assumed by the Government through the execution of contracts. The legally binding responsibilities of the parties shall be set forth in their respective contracts.

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